

02P10408

B3

(19)



Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11) Publication number:

**0 304 300 B1**

(12)

**EUROPEAN PATENT SPECIFICATION**(45) Date of publication of patent specification: 30.12.92 (51) Int. Cl.<sup>5</sup>: **G21K 4/00**(21) Application number: **88307647.3**(22) Date of filing: **18.08.88**

(54) Radiation image storage panel having low refractive index layer and protective layer.

(30) Priority: 18.08.87 JP'206017/87  
24.08.87 JP 211066/87  
10.06.88 JP 141522/88

(43) Date of publication of application:  
22.02.89 Bulletin 89/08

(45) Publication of the grant of the patent:  
30.12.92 Bulletin 92/53

(84) Designated Contracting States:  
DE GB NL

(56) References cited:  
EP-A- 0 084 818  
DE-A- 3 031 267

(73) Proprietor: **KONICA CORPORATION**  
26-2, Nishishinjuku 1-chome, Shinjuku-ku  
Tokyo 160(JP)

(72) Inventor: **Nakazawa, Masayuki**  
c/o Konica Corporation 1 Sakura-machi  
Hino-shi Tokyo(JP)  
Inventor: **Nitta, Masaaki**  
c/o Konica Corporation 1 Sakura-machi  
Hino-shi Tokyo(JP)  
Inventor: **Tsuchino, Hisanori**  
c/o Konica Corporation 1 Sakura-machi  
Hino-shi Tokyo(JP)

(74) Representative: **Ellis-Jones, Patrick George**  
**Armine et al**  
**J.A. KEMP & CO. 14 South Square Gray's Inn**  
**London WC1R 5EU(GB)**

**EP 0 304 300 B1**

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid (Art. 99(1) European patent convention).

Rank Xerox (UK) Business Services

## Description

This invention relates to a radiation image storage panel having a stimuable phosphor layer. More particularly, it relates to a panel which is protected from deterioration due to the penetration of water, which endures for a long period of use, and which has high sharpness.

Radiation images like X-ray images are often used in the diagnosis of diseases.

In order to obtain X-ray images, X-ray image converting methods of directly taking out images from phosphors have been devised in place of using light-sensitive silver halide materials.

The methods include a method in which radiation (generally an X-ray) transmitted through a subject is absorbed by a phosphor, and thereafter this phosphor is excited by light or heat energy to radiate the radiation energy stored by above absorption as fluorescence, which fluorescence is detected and formed into an image.

U.S. Patent No. 3,859,527 and Japanese Provisional Patent Publication No. 12144/1980 disclose radiation image storage methods in which a stimuable phosphor is used and visible light or infrared rays are used as the stimulating light.

This method employs a radiation image storage panel (hereinafter often referred to as a "storage panel" or "panel") comprising a support bearing thereon a stimuable phosphor layer (hereinafter often referred to simply as a "stimuable layer"), wherein radiation transmitted through a subject is applied to the stimuable layer to store radiation energy corresponding to the radiation transmission degree of all areas of the subject to form an image, and thereafter the stimuable layer is scanned with a stimulating light to convert the radiation energy stored in the areas into light, thus obtaining an image according to signals based on the strength of this light.

This image may be reproduced as a hard copy or may be reproduced on a CRT.

The storage panel used in this method irradiates stored energy when scanned by stimulating light after radiation image information has been stored so that radiation images can again be stored after scanning. The storage panel can thus be used repeatedly.

The above storage panel desirably lasts for a long time or many times of repeated use without the image quality of the obtained radiation images deteriorating. In order to satisfy this requirement, the stimuable layer should be sufficiently protected from outer physical or chemical excitation.

In conventional storage panels, there has been employed a method in which a protective layer covers a surface of the stimuable layer on a support of the storage panel in order to solve the above problems. This protective layer is, as disclosed in, for example, Japanese Provisional Patent Publication No. 42500/1984, formed by directly coating a coating solution for the protective layer on a stimuable layer or formed by adhering a previously and separately formed protective layer on a stimuable layer.

A thin protective layer comprising an organic polymer has generally been used as the protective layer. The reason why such a thin protective layer has been used is to prevent lowering of sharpness of the image obtained from a storage panel as much as possible.

The relationship between sharpness and thickness of a protective layer of a storage panel having a stimuable layer is shown in Table 1 using MTF (Modulation Transfer Function) of a spatial frequency of 1 lp/mm and 2 lp/mm. PET is a polyethylene terephthalate film.

Table 1

Protective layer	Thickness ( $\mu$ m)	1 lp/mm (%)	2 lp/mm (%)
None	-	78	41
PET	8.5	74	39
PET	11	64	35
PET	25	59	29
PET	70	54	26
PET	175	48	24
Glass	550	43	20

As shown in Table 1, when the protective layer is thicker, the sharpness is lower. A reason that may be mentioned is that reflected scattering light of the incident stimulating light at a surface of a stimuable layer

is reflected at the interface between the protective layer and air, and is then re-incident on the stimuable layer. When the protective layer is thicker, the reflected scattering light extends further and the result is image information of images other than the images which should be detected. Thus the sharpness is lowered.

5 In a conventional film/screen system for X-ray photography it is preferred that the panel should be such that the MTF at 1 lp/mm is not less than about 65 % and at 2 lp/mm is not less than about 35 %. Accordingly, in the protective layer of the conventional storage panel an organic polymer film having a thickness of about 10  $\mu\text{m}$  or so is used.

10 However, this basic problem of decrease in sharpness due to a protective layer has not yet been solved. It is strongly desired to have a storage panel with increased sharpness.

Furthermore the thin protective layer comprising an organic polymer which is conventionally used is transmissive to some extent of water and/or moisture. Thus, the stimuable layer absorbs water so that the storage panel's sensitivity to radiation is lowered. Deterioration of stored energy subsequent to irradiation of the radiation and before irradiation of the stimulating light fading is also large, and thus fluctuation and/or  
15 deterioration of the image quality of the obtained radiation images is/are caused.

For example, the moisture permeability coefficient of PET having a thickness of 10  $\mu\text{m}$  is about 60  $\text{g/m}^2 \cdot 24 \text{ hr}$  and thus at most 60 g of moisture per unit area can pass through in a day. Even in an oriented polypropylene (hereinafter abbreviated to "OPP"), the moisture permeability coefficient is about 15  $\text{g/m}^2 \cdot 24 \text{ hr}$ .

20 Furthermore in a conventional storage panel having the above-mentioned thin protective layer, since the surface hardness of the protective layer is low, flaws on the surface of the protective layer occur due to contact with a machine component such as a conveying roller during transmission. Additionally flaws are likely to develop due to a crack or a fold in the stimulating layer since the impact resistance is insufficient in a thin protective layer. Therefore, there is a problem that the image quality of the obtained radiation image  
25 becomes worse with repeated use.

On the other hand, when the protective layer is thick, the defects caused by a thin film can be overcome but again the sharpness is lowered as mentioned above. It is desired, with two contrary phenomena, to improve the aspects of moisture resistance, strength and impact resistance without impairing the sharpness.

30 One attempt to provide an improved panel has been made by sealing the edge portions of a laminated product comprising a support, a stimuable phosphor and a protective layer in order to improve the humidity resistance. As sealing methods there have been employed, for example, the method in which edge portions are sealed with a sealing agent and the sealing agent is solidified by a solidifying agent from the outside (Japanese Provisional Patent Publication No. 237099/1986) or the method in which edge portions are sealed  
35 when being coated with elongated portions of the protective layer (Japanese Provisional Patent Publication No. 237100/1986).

However, by sealing only by the above methods, the effect of water permeating the protective layer to the stimuable layer cannot be sufficiently prevented.

40 As described above, in a storage panel which employs the conventional stimuable phosphor, there is the disadvantage that sharpness necessarily becomes low by providing a protective layer.

In the conventional storage panel, when a thin protective layer is employed in order to prevent lowering of the sharpness of the images, there are problems that fluctuation or deterioration of the radiation images obtained are caused by chemical stimulations from the outside, particularly by permeation of water or moisture, or breakage of the stimuable layer is caused by physical stimulations from the outside. On the  
45 other hand when a thick protective layer is used to protect from such chemical and physical stimulations, there is a problem that the sharpness of the images becomes low.

Furthermore when preparing a conventional storage panel, adhesion between a protective layer and a stimuable layer and/or the stimuable layer and a support may be sometimes made using an adhesive agent. There is a problem in that heat used to heat and cure the adhesive agent causes the storage panel  
50 to deform or warp, and as a result damage is caused to the stimuable layer which reduces the image quality.

Moreover, even when a protective layer is provided on a stimuable layer and the edges of the panel are sealed, a stimuable phosphor absorbs moisture during preparation of the panel so that the initial characteristics of the storage panel become low. Furthermore, fluctuation of characteristics of each storage  
55 panel is a problem since the extent of the above moisture absorption depends largely on the atmosphere during the preparation. Thus, when heating and drying are carried out after sealing the edges of the storage panel, there is a problem that the air inside the storage panel expands whereby it destroys or deforms the panel. Therefore it is not preferred.

EP-A-84,818 discloses a radiation image storage panel wherein an adhesive layer and a protective film are provided, in this order starting from the phosphor layer side.

The present invention seeks to provide a storage panel having a high durability and long lifetime, which has a stimuable layer protected from outer physical excitation and chemical stimulation, which has  
 5 sufficient protection against water, without impairing the sharpness of images obtained, which can maintain high sensitivity, high sharpness and high graininess of the stimuable layer for a long time and which can be used with good conditions.

The present invention also seeks to provide a storage panel which solves the problems of deformation of a support or a protective layer caused by heat used during preparation of the storage panel or by  
 10 temperature change during use. Thus, damage caused to the stimuable layer causing lowering of quality of images is reduced.

The present invention provides a radiation image storage panel having a stimuable phosphor layer, a protective layer and an intermediate layer provided between the stimuable layer and the protective layer, on a support, characterized in that the intermediate layer has a lower refractive index than the protective  
 15 layer.

In the panel of the present invention a second layer having a higher refractive index than the intermediate layer having a lower refractive index than the protective layer may be provided between the intermediate layer and the stimuable layer.

The intermediate layer may be composed of a protective layer supporting member with a thickness the  
 20 same or greater than that of the stimuable layer provided between the stimuable phosphor layer and the protective layer so as to seal the edges of the stimuable layer.

A first moistureproof member with a thickness the same or greater than that of the stimuable layer may be provided between the support and the protective layer so as to seal the edges of the stimuable layer, and the intermediate layer may comprises a void formed by the first moistureproof member, the support  
 25 and the protective layer being filled with a second moistureproof member.

The protective layer may be made up of at least two layers having different moisture-absorption characteristics from each other.

A preferred panel of the present invention comprises the stimuable layer and protective layer on a support, a first layer having a lower refractive index than the protective layer provided between the  
 30 stimuable layer and the protective layer, and a second layer having a higher refractive index than that of the first layer provided between the first layer and the stimuable layer, and the second layer having high moisture-absorption characteristics.

The present invention also provides a process for preparing a radiation image storage panel having a stimuable phosphor layer, a protective layer and an intermediate layer provided between the stimuable  
 35 layer and the protective layer, on a support, wherein the intermediate layer has a lower refractive index than the protective layer, and wherein the intermediate layer is formed by providing a protective layer supporting member having a thickness greater than that of the stimuable layer such that the stimuable layer is surrounded and sealed by the protective layer supporting member, which comprises providing at least one notch in the protective layer supporting member which functions as a vent hole, heating and drying the  
 40 panel, and then sealing the notch or notches.

Fig. 1 is a sectional view showing the basic constitution of a panel of the present invention; Figs. 2 to 6, 8 to 13, 15 to 18, 20, 22 and 23 are sectional views of examples of panels of the present invention; Fig. 7 is a view showing one example of a worked shape of a first moistureproof member; Figs. 14 and 19 are plane views of Figs. 13 and 18 respectively; and Fig. 21 is a schematic diagram showing a radiation image  
 45 storage method using a storage panel of the present invention. In the Figures 1 (1a and 1b) is a protective layer, 2 (2a and 2b except for 2b in Fig.3) is an intermediate layer having a lower refractive index than the protective layer 1, 3 is a stimuable layer, 4 is a support, 5 is a protective layer supporting member, 51 is a non-hygroscopic supporting member, 52 is a hygroscopic supporting member, 6 is a spacer, 7a is a first moistureproof member, 7b is a second moistureproof member, 8, 81 and 82 are sealing members, 9 is an adsorbing agent, 10 is an elastic sealing agent, 10a is an elastic sealing agent having lower elasticity and  
 50 10b is an elastic sealing agent having higher elasticity.

The present invention is now further explained in detail referring to the drawings.

Fig. 1 is a sectional view of part of an example of a storage panel of the present invention. 1 is a protective layer, 2 is an intermediate layer having a lower refractive index than the protective layer 1, 3 is a  
 55 stimuable layer, and 4 is a support.

As a material which can form the protective layer, that which has excellent light-transmission and which may be formed into sheets may be mentioned. It is preferred to use a layer which has a high light-transmittance over a wide range of wavelengths in order to transmit stimulating light or emitted light with

good efficiency, more preferably a layer having a light-transmittance of 80 % or more.

Examples include sheet glasses such as quartz glass, borosilicate glass or chemically reinforced glass, and organic polymers such as PET, OPP or polyvinyl chloride. Borosilicate glass has a light-transmittance of 80 % or higher in the wavelength range of from 330 nm to 2.6  $\mu\text{m}$ . In quartz glass a high light-transmittance can be obtained even for shorter wavelengths than above.

The protective layer may be a single layer or a multi-layer, or may be formed by two or more layers of different materials. For example, a composite film comprising two or more organic polymer membrane layers may be employed. As methods for preparing such a composite polymer film, there may be mentioned dry laminating, extrusion laminating or co-extrusion coating laminating. A combination of two or more protective layers is not limited to combination of organic polymers; sheet glasses themselves, or a sheet glass and an organic polymer layer, may, for example, be used. As an example of a method for combining sheet glass and a polymer layer, a coating solution for the protective layer is directly coated on the sheet glass or a polymer protective layer which has been previously prepared is adhered onto the sheet glass. Two or more protective layers may be adhered or separated from each other.

By employing at least two layers having different moisture-absorption characteristics as the protective layer, a further improvement in moisture resistance can be realized.

Here, the expression "different moisture-absorption characteristics" means that if the protective layer comprises two layers A and B, the equilibrium moisture-absorption isothermic curve of layer A at a temperature at which the storage panel is exposed in the usual conditions of use is different from that of layer B at said temperature.

In Fig. 2A, an example of a storage panel having two layers making up the protective layer is shown as a sectional view. In the figure, 1a and 1b are protective layers; 1a is in contact with a stimuable layer and is a protective layer having a higher moisture-absorption characteristic; the outermost layer 1b is a protective layer having a lower moisture-absorption characteristic. Also, as in Fig. 1, 2 is an intermediate layer, 3 is a stimuable layer and 4 is a support. By constituting the protective layer as in Fig. 2A, the humidity resistance of the storage panel can be improved greatly and therefore this constitution is particularly preferred. Water or water vapor present outside the storage panel is prevented from permeating inside the storage panel by the protective layer 1b. However, when an organic polymer is used as the protective layer 1b, it is impossible to shut out water completely and some water always permeates through. The amount of water transmittance generally increases in proportion to difference in humidity between the outside and the inside of the protective layer 1b. Water which has permeated through the protective layer 1b reaches the surface of a protective layer 1a, but the protective layer 1a has a high moisture-absorption characteristic so that it retains the water at the surface of the side adjacent to the layer 1b and inside the layer, whereby it prevents arrival of the water at the stimuable layer. As a result, deterioration due to absorption of water by the stimuable layer is less than that of a conventional storage panel.

A composite protective layer having the layer constitution shown in Fig. 2A can have a moisture permeability in the direction from 1b to 1a which is extremely low and in the direction from 1a to 1b which is relatively large by selecting suitable materials for the protective layers. Generally speaking, a membrane having low moisture-absorption characteristics has the property that its moisture permeability coefficient has little dependence on humidity, and a membrane having high moisture-absorption characteristics has the property that its moisture permeability coefficient has a great dependence on temperature. Accordingly, since the moisture-absorption characteristics of the protective layer 1b depend little on humidity, and since the moisture-absorption characteristics of the protective layer 1a depend largely on temperature, a composite system of both shows two sides of moisture permeability in the well known composite membrane. That is, the moisture permeability when 1b is provided so as to contact with a high humidity side is smaller than when 1a is provided at the high humidity side. If the difference between the moisture permeabilities is enlarged by a suitable combination of materials for the protective layers, a storage panel which has excellent humidity resistance and which, when the stimuable layer absorbs water, rapidly releases water by exposing it to fresh air having a low humidity can be prepared.

When sheet glass is employed as the protective layer 1b, it is possible substantially to completely shut out water from the surface of the panel. However, water may sometimes permeate into side edges of the protective layer and the support. At that time, the protective layer 1a having high moisture-absorption characteristics absorbs the water and prevents the water reaching the stimuable layer.

In Fig. 2B, another example of a structure of a storage panel of the present invention is shown. The storage panel shown in Fig. 2B has a protective layer 1b having relatively low moisture-absorption characteristics, adjacent to a stimuable layer, and a protective layer 1a having relatively high moisture-absorption characteristics, positioned outside the above. Water present outside the radiation image storage panel is retained at the surface and inside the protective layer 1a having high moisture-absorption

characteristics. Permeated water which cannot be retained in the protective layer 1a is prevented from permeating into the stimuable layer by the protective layer 1b having low moisture-absorption characteristics. It is particularly preferred that the protective layer 1b is composed of a material which has low moisture-absorption characteristics. Another protective layer having low moisture-absorption characteristics may further be formed outside protective layer 1a.

The constitution of the protective layer of the storage panel of the present invention is not limited to the examples shown in Fig. 2.

In the panel of the present invention, it is preferred that, among the two or more protective layers which coat the surface of a stimuable layer, at least the outermost protective layer has a high surface hardness. By providing a protective layer having a high surface hardness, damage by physical impact, for example from a panel conveying system or other machinery part, during repeated use of the panel and deterioration of the image quality of radiation images accompanied by the above can be prevented.

When an organic polymer is used as the protective layer, a method for the formation thereof may be one as mentioned below:

As the first method, as disclosed in Japanese Provisional Patent Publication No. 42500/1984, a solution prepared by dissolving a polymer having high transparency in a suitable solvent is coated on a surface on which is to be formed a protective layer, and then dried to form the protective layer.

As the second method, as disclosed also in Japanese Provisional Patent Publication No. 42500/1984, a suitable adhesive agent is applied to one surface of a thin film comprising a transparent polymer substance and a protective layer is provided on a surface on which is to be formed a protective layer.

As the third method, as disclosed in Japanese Provisional Patent Publication No. 176900/1986, a coating solution containing one or both of a radiation curing type resin or a thermosetting type resin is coated on the surface to be provided with a protective layer and the coating solution is cured by irradiation of an ultraviolet ray or an electron beam and/or by heating with an apparatus as disclosed in the above publication.

When there are at least two protective layers they are all not necessarily prepared by the same method.

In the storage panel of the present invention, the protective layers may comprise, as described above, a combination of two or more layers having different moisture-absorption characteristics. Preferred materials for the protective layer which has relatively low moisture-absorption characteristics are sheet glass, polyethylene, polytetrafluoroethylene, polytrifluoro-chloroethylene, polypropylene, tetrafluoroethylene-hexafluoroethylene copolymer, polyvinylidene chloride, polyvinyl isobutyl ether, polyethylene terephthalate, vinylidene chloride-vinyl chloride copolymer, vinylidene chloride-acrylonitrile copolymer, vinylidene chloride-isobutylene copolymer, polystyrene, or an epoxy series or acryl series polymer, particularly preferably sheet glass, polyethylene or polytetrafluoroethylene. Preferred materials for the protective layer having relatively high moisture-absorption characteristics are polyvinyl alcohol, ethylene-vinyl alcohol copolymer, polyacrylamide, polyglycine, polymethacrylic acid, polyacrylic acid, polyvinyl pyrrolidone, polyvinyl amine, cellulose diacetate, cellulose triacetate, Nylon 4, Nylon 6, Nylon 12, Nylon 66 (all trade names), polyvinyl acetate, or polymethylallyl alcohol, particularly preferably polyvinyl alcohol and ethylene-vinyl alcohol copolymer.

It is particularly preferred that at least one material is selected from the group mentioned as the materials for the protective layer having low moisture-absorption characteristics and at least one material is selected from the group mentioned as the materials for the protective layer having high moisture-absorption characteristics, and that the former is provided at the outside and the latter is provided at the inside, that is on the side adjacent to a stimuable layer.

The thickness of the protective layer is practically 30  $\mu\text{m}$  to 4 mm; 100  $\mu\text{m}$  or more is preferred to obtain a good moistureproof property. A thickness of 200  $\mu\text{m}$  or more is more preferred since a storage panel which has excellent durability and lifetime can be obtained. It is preferred that the moisture permeability of the protective layer is 10  $\text{g/m}^2 \cdot 24 \text{ hr}$  or less, more preferably 5.0  $\text{g/m}^2 \cdot 24 \text{ hr}$  or less from the point of moisture-proofness. The moisture permeability is measured according to the cup method (JIS Z 0208).

It is preferred that an anti-reflective layer, for example of  $\text{MgF}_2$ , is provided on the surface of the protective layer, since this allows effective permeation of stimulating light and emitted light, whereby lowering in sharpness is reduced.

The refractive index of the protective layer is not particularly limited, but in practice it is generally from 1.4 to 2.0.

The intermediate layer of the storage panel of the present invention comprises a material having a lower refractive index than that of the protective layer. Due to the presence of this layer, even if the protective layer is thick, there is little lowering in sharpness. Materials shown in Table 2 may, for example, be

employed; it is preferred to use them in the state of a thin film formed by the vapor deposition method. Liquid layers as shown in Table 3 may also be used. It is particularly preferred to use a gaseous layer such as air, nitrogen or argon or a vacuum layer which has a refractive index of substantially 1, since its effect of preventing lowering in sharpness is remarkable.

The thickness of the intermediate layer is practically from 0.05  $\mu\text{m}$  to 3 mm.

Table 2

Material	Refractive index
CaF <sub>2</sub>	1.23 to 1.26
Na <sub>3</sub> AlF <sub>6</sub>	1.35
MgF <sub>2</sub>	1.38
SiO <sub>2</sub>	1.46

Table 3

Material	Refractive index
Ethyl alcohol	1.36
Methyl alcohol	1.33
Diethyl ether	1.35

The intermediate layer may be adjacent to or apart from the stimuable layer, but it is preferably adjacent to ensure a sufficiently small lowering in sharpness. Therefore, when the intermediate layer is a liquid layer, a gaseous layer or a vacuum layer, it may be used as it is. However, when the intermediate layer is formed on the surface of the protective layer with, for example, the above CaF<sub>2</sub>, Na<sub>3</sub>AlF<sub>6</sub>, MgF<sub>2</sub> or SiO<sub>2</sub>, the stimuable layer and the intermediate layer should be adhered with, for example, an adhesive agent. In this case, the refractive index of the adhesive agent is preferably similar to that of the stimuable layer.

The storage panel of the present invention as shown in the partial sectional view in Fig. 3 may have a structure such that a first layer having a lower refractive index than a protective layer is provided between the stimuable phosphor layer and the protective layer, and a second layer having a higher refractive index than the first layer is provided between the first layer and the stimuable phosphor layer.

In Fig. 3, 1 is a protective layer, 2a is a first layer, 2b is a second layer, 3 is a stimuable layer and 4 is a support. In the following, the first layer 2a is called a lower refractive index layer and the second layer 2b is called a higher refractive index layer.

The first layer (a lower refractive index layer) may use the same material as in the intermediate layer used for the storage panel shown in Fig. 1. The thickness of the lower refractive index layer is practically from 0.05  $\mu\text{m}$  to 3 mm.

The second layer (a higher refractive index layer) comprises a substance which has higher refractive index than that of the first layer. For example, an organic polymer film such as PET may be used, or a deposition substance used, for example, for an anti-reflection film may be used. As deposition substances, there may be mentioned, for example, those in Table 4.

The thickness of the higher refractive index layer is practically from 30 nm to 500  $\mu\text{m}$ . However, in order to ensure that there is little lowering of sharpness, 50  $\mu\text{m}$  or less is preferred and 10  $\mu\text{m}$  or less is more preferred.

The higher refractive index layer may be adhered to or separated from a stimuable layer. An adhesive agent may, for example, be used to adhere the higher refractive index layer and the stimuable layer.

In this case, the refractive index of the adhesive agent is preferably similar to that of the stimuable layer or to that of the higher refractive index layer.

Table 4

Material	Refractive index
Al <sub>2</sub> O <sub>3</sub>	1.62
Sb <sub>2</sub> O <sub>3</sub>	2.04
CeO <sub>2</sub>	2.42
CeF <sub>3</sub>	1.63
La <sub>2</sub> O <sub>3</sub>	1.95
LaF <sub>3</sub>	1.59
PbF <sub>3</sub>	1.75
NdF <sub>3</sub>	1.60
Pr <sub>6</sub> O <sub>11</sub>	1.92
SiO	2.0
SiO <sub>2</sub>	1.46
TiO <sub>2</sub>	2.2 to 2.7
ThO <sub>2</sub>	1.8
ThF <sub>4</sub>	1.52
ZnS	2.35
ZrO <sub>2</sub>	2.1

In addition, if a substance which has high moisture-absorption characteristics is employed as the higher refractive index layer, better humidity resistance can be provided. Here, the moisture-absorption characteristics means equilibrium moisture absorbance.

When a substance which has high moisture-absorption characteristics is employed for the higher refractive index layer 2b in Fig. 3, the higher refractive index layer adsorbs and retains water permeated through the protective layer 1 and the lower refractive index layer 2a and/or water permeated through the edge portions of the storage panel so that it prevents arrival of water to the stimuable layer. It also makes the stimuable layer drier because a second intermediate layer having high moisture-absorption characteristics removes water which has adsorbed to the stimuable layer when manufacturing the storage panel. Therefore, by using a protective layer having a relatively greater thickness and low moisture permeability, and further by using a substance having higher moisture-absorption characteristics for the higher refractive index layer (the second intermediate layer), a storage panel having excellent humidity resistance can be prepared. A higher value of equilibrium moisture absorbance of the second intermediate layer is preferred. The equilibrium moisture absorbance of the second intermediate layer at a temperature of 25 °C and a relative humidity of 65 % is practically 1 % or more; 2 % or more is preferred and 5 % or more is particularly preferred. Materials having higher moisture-absorption characteristics may be selected from organic polymers. Preferred examples of the organic polymers are polyvinyl alcohol, polyacrylamide, polyglycine, polymethacrylic acid, polyacrylic acid; polyvinyl pyrrolidone, polyvinyl amine, cellulose diacetate, cellulose triacetate, Nylon 4, Nylon 6, Nylon 12, Nylon 66 (all trade names), polyvinyl acetate and polymethylalyl alcohol. The material for the second intermediate layer having higher moisture-absorption characteristics is not limited to only the organic polymers; any material may be employed so long as it has high equilibrium moisture absorbance.

When a gaseous layer or a vacuum layer is provided as the intermediate layer, there is for example the method in which, as shown in Fig. 4, a spacer material 6 is sprayed between the protective layer and the stimuable layer to provide a gaseous layer or a vacuum layer. A preferred material for the spacer is fine glass fiber tips having a diameter of several μm, which have been used as a spacer material for a liquid crystal panel. Also, as shown in Fig. 5, there is the method in which a protective layer supporting member (hereinafter sometimes abbreviated to "spacer") having a thickness greater than that of the stimuable layer is provided such that the stimuable layer is surrounded by the protective layer supporting member.

The storage panel shown in Fig. 5 has a stimuable layer 3, an intermediate layer 2 and a protective layer 1 on a support 4 in this order, and it further has a protective layer supporting member 5 as a constituting element. The stimuable layer 3 is surrounded by the protective layer supporting member 5 when sealing from the outer atmosphere. One edge of the protective layer supporting member 5 is adhered to the support 4, and the other edge is adhered to the protective layer 1. The edge portions of the stimuable layer 3 and the protective layer supporting member 5 may contact each other or may be separated. The intermediate layer 2 and the stimuable layer 3 are constituted when sealing from the outer atmosphere by the protective layer 1, the support 4 and the protective layer supporting member 5.



The protective layer supporting member used in the storage panel according to the present invention shown in Fig. 5 is not particularly limited so long as a lower refractive index layer can be formed under the conditions of sealing from the outer atmosphere; a glass, ceramic, meta or plastic can, for example, be employed.

The protective layer supporting member preferably has a moisture permeability of  $10 \text{ g/m}^2 \cdot 24 \text{ hr}$  or less. A large moisture permeability is not preferred since the stimuable phosphor deteriorates due to water which permeates from the outside.

The thickness of the protective layer supporting member (a in Fig. 5) may be the same as or larger than that of the stimuable layer.

Where the thicknesses of the protective layer supporting member and the stimuable layer are the same as each other the intermediate lower refractive index layer may, for example, be a vacuum layer. In this case the vacuum layer is present and optically separates the stimuable layer and the protective layer. Thus it acts as the intermediate lower refractive index layer.

In case where the thickness of the protective layer supporting member exceeds that of the stimuable layer, the thickness of the protective layer supporting member can be determined in connection with the thickness of the intermediate lower refractive index layer to be formed.

The width of the protective layer supporting member (b in Fig. 5) is determined mainly in connection with the moisture resistance (the above moisture permeability) of an adhered portion of the protective layer supporting member with a support and a protective layer, and is preferably from 1 to 30 mm. The width of the protective layer supporting member is preferably not too small, from the viewpoints of stability, strength and moisture resistance of the protective layer supporting member. The width is preferably not too large since the storage panel is then larger than necessary. The moisture permeability at the adhered portion of the protective layer supporting member with the support and the protective layer is preferably  $10 \text{ g/m}^2 \cdot 24 \text{ hr}$  or less.

The protective layer supporting member is necessarily adhered to the support and the protective layer in order to provide moisture resistance to the storage panel and to retain a constant thickness of the intermediate lower refractive index layer. In order to adhere the protective layer supporting member to the support and the protective layer an adhesive agent is, for example, used. Preferred adhesive agents have moisture resistance. More specifically, there may be employed an organic polymer series adhesive agent such as an epoxy series resin, a phenol series resin, a cyanoacrylate series resin, a vinyl acetate series resin, a vinyl chloride series resin, a polyurethane series resin, an acrylic series resin, an ethylene-vinyl acetate series resin, a polyolefin series resin, a chloroprene series rubber, a nitrile series rubber or a silicone series adhesive agent. Among these an epoxy series resin or a silicone series resin used for encapsulation of a semiconductor device or an electronic part is preferred since they have excellent moisture resistance. An epoxy resin series adhesive agent is particularly suitable since it has low moisture permeability.

In order to improve adhesiveness at the adhered portions of the protective layer supporting member and the support or the protective layer supporting member and the protective layer, a subbing layer may be formed at the contacting surfaces of the protective layer supporting member, the support and the protective layer with other layers or may be subjected to a roughening treatment of the surfaces thereof.

The intermediate layer comprises a substance which has a lower refractive index than that of the protective layer, and by the presence of the layer, lowering in sharpness can be made small even if the thickness of the protective layer is made greater. The material constituting the intermediate layer is not limited at all so long as it has a lower refractive index than that of the protective layer.

In the storage panel of the present invention, it is effective to employ, as a material for the protective layer supporting member, a material which has higher moisture-absorption characteristics than those of the stimuable phosphor.

In this case, as the material for the protective layer supporting member, there may be employed, for example, a water absorptive polymer such as polyvinyl alcohol, ethylene-vinyl alcohol copolymer, polyacrylamide, polyglycine, polymethacrylic acid, polyacrylic acid, polyvinyl pyrrolidone, polyvinyl amine, cellulose diacetate, cellulose triacetate, Nylon 4, Nylon 6, Nylon 12, Nylon 66 (all tradenames), polyvinyl acetate or polymethylallyl alcohol, or a moisture absorptive sheet or dispersing a moisture absorbing agent such as a silica gel or calcium carbonate in a polymer.

A spacer may have shapes, for example as shown in Figs. 9 to 12. In addition, parts of the spacer may comprise a material having moisture-absorption characteristics.

In this case, the storage panel of the present invention preferably has a structure as shown in Fig. 8, where the outside of the spacer or edges of the storage panel are sealed with a sealing member 82, since the moisture-proof effect can be increased. It is particularly preferred that the spacer portion having

moisture-absorption characteristics should not be directly exposed to the open air. The above structure should be used in the case that the moisture permeability of the spacer exceeds  $10 \text{ g/m}^2 \cdot 24 \text{ hr}$ .

For sealing, methods wherein sealing is carried out by glass fusion using the above sealing member or a sealing glass such as a low melting point glass, or by sealing at an elongated portion of the protective layer may be mentioned. The glass fusion method provides an excellent hermetic property. In this case, the spacer may only adhere to the support and/or the protective layer.

For providing better moisture resistance to the storage panel of the present invention, it is preferred to use a structure in which, as shown in Fig. 6, a first moistureproof member 7a with a thickness the same or greater than that of the stimuable phosphor layer is provided between the support and the protective layer so as to seal the edges of the stimuable phosphor layer. Avoid portion formed by the first moistureproof member, the support and the protective layer is filled with a second moistureproof member 7b

The storage panel of the present invention shown in Fig. 6 has, on a support 4, a stimuable layer 3, an intermediate layer 2 and a protective layer 1 in this order and includes, as other constituting elements, a first moistureproof member 7a and a second moistureproof member 7b. The first moistureproof member 7a is provided at edge portions of the stimuable layer 3; one end of the first moistureproof member 7a is adhered to the support, and the other end is adhered to the protective layer 1. The edge portions of the stimuable layer 3 and the first moistureproof member 7a contact or be separated from each other. In a void portion of the edge portions of the first moistureproof member, or the void portion formed by the protective layer 1, the first moistureproof member 7a and the support, a second moistureproof member 7b is filled therein.

In the storage panel of the present invention shown in Fig. 6, it is the most important characteristic feature that the first moistureproof member and the second moistureproof member are present between the support and the protective layer. The second moistureproof member prevents permeation of water from the outer atmosphere into the storage panel, and the first moistureproof member prevents permeation of a small amount of water which is passed through the second moistureproof member to the side of the stimuable layer.

The first moistureproof member and the second moistureproof member are not limited so long as they have moisture resistance, but it is preferred that the moisture permeability of the first moistureproof member is lower than that of the second moistureproof member. Objects of the first moistureproof member include constantly maintaining the distance between the support and the protective layer by supporting the protective layer as preventing permeation of a small amount of water passed through the second moistureproof member to the side of the stimuable layer. An object of the second moistureproof member is to prevent permeation of water from the outer atmosphere.

The moisture permeability of both of the moistureproof members is preferably regulated as follows. It is preferred that the first moistureproof member has a moisture permeability of  $10 \text{ g/m}^2 \cdot 24 \text{ hr}$  or less, and more preferably  $5 \text{ g/m}^2 \cdot 24 \text{ hr}$  or less. The moisture permeability of the second moistureproof member is preferably  $20 \text{ g/m}^2 \cdot 24 \text{ hr}$  or less, and more preferably  $10 \text{ g/m}^2 \cdot 24 \text{ hr}$  or less. The moisture permeability is measured according to the cup method (JIS Z 0208). The moisture permeability at the adhered portion of the moistureproof material with the protective layer and the support is preferably the same as or less than that of the moistureproof member.

The second moistureproof member is required to adhere to the support and the protective layer.

The first moistureproof member is preferably a material which can be processed into a sheet, such as a glass, ceramic, metal or polymer.

As a glass, a chemically reinforced glass or a crystallized glass may, for example, be used. As a ceramic, a sintered plate of alumina or zirconia may, for example, be used. As a metal, a metal sheet or a metal plate of, for example, aluminium, iron, copper or chromium or materials of which the above metal sheet or metal plate is coated with an oxide of the above metal may, for example, be used. As a polymer, a film of, for example, cellulose acetate, polyester, polyethylene terephthalate, polyamide, polyimide, triacetate, polycarbonate, polyethylene or epoxy resin; or a sheet of butadiene-styrene rubber, butadiene-acrylonitrile rubber, isoprene rubber, chlorosulfonated polyethylene rubber, isobutylene rubber, isobutylene-isoprene rubber, acrylic rubber, polysulfide synthetic rubber, urethane rubber, natural rubber, propylene rubber, styrene rubber, butadiene rubber, silicone rubber or fluorine rubber may, for example, be mentioned.

As the second moistureproof member, materials as in the first moistureproof member may be exemplified, but in addition to the above, there may be mentioned a resin which cures by mixing two liquids such as a two pack-type urethane series adhesive agent, a two pack-type modified acrylate series adhesive agent, a two pack-type modified acrylic series adhesive agent or a two pack-type epoxy series adhesive agent which effects a polycondensation reaction or cross-linking reaction; or a radiation cure type resin

which is cured by an electromagnetic wave or a corpuscular beam by irradiation of an electromagnetic wave or a corpuscular beam such as an X-ray,  $\alpha$ -ray,  $\beta$ -ray,  $\gamma$ -ray, high energy neutron beam, electron beam or ultraviolet ray.

The first moistureproof member is positioned so as to surround the stimuable layer after processing to the shape as shown in Fig. 7 when a sheet like member is used. Fig. 7 is a drawing showing examples of the processed shape of the first moistureproof member. Fig. 7A shows a member hollowed into the shape of box which has particularly excellent moisture resistance due to its lack of a joint. Fig. 7B shows a combination of two moistureproof members having an L shape, and Fig. 7C shows a combination of four stick like sheets. For adhesion of the first moistureproof member and the support or the protective layer, an adhesive agent which may be used as the above second moistureproof member is preferably used. In the case where the moisture resistance of the second moistureproof member is high and the moisture permeability is  $5.0 \text{ g/m}^2 \cdot 24 \text{ hr}$  or less, the first moistureproof member may function substantially only to retain the protective layer. In this case, the first moistureproof member need not necessarily adhere to the support and the protective layer.

In the case where a sheet like material is used as the second moistureproof member, it is necessary to adhere the member to the support and the protective layer. The adhesive agent which is used as the above second moistureproof member may be used.

The thicknesses of the first and second moistureproof members are not limited so long as they are the same or thicker than that of the stimuable layer.

The widths of the first and second moistureproof members are preferably as large as possible since the moisture resistance is then high, but practically it is from 1 to 30 mm, more preferably from 2 to 10 mm. If the width is too small, not only is moisture resistance low but also the moisture resistance is remarkably lowered due to defects such as pinholes. If the width is too large the effective utilizable area of the storage panel decreases.

Since an intermediate lower refractive index layer is provided, it is necessary to make the thicknesses of the first and the second moistureproof members the same as or thicker than that of the stimuable layer. Even if the thicknesses of the first and the second moistureproof members are the same as that of the stimuable layer, if the stimuable layer is not adhered to the protective layer, for example with an adhesive agent, an intermediate lower refractive index layer can be provided between the protective layer and the stimuable layer.

The modulus of elasticity herein mentioned means the longitudinal modulus (Young's modulus), and the above moistureproof members are preferably selected such that the modulus of elasticity of the first moistureproof member is lower than that of the second moistureproof member. It is thus be possible to prevent defects of a protective layer and/or a support of the storage panel by absorbing thermal strain at sealing the storage panel using the second moistureproof member. Examples of combinations of such a first moistureproof member and a second moistureproof member are urethane rubber-polyethylene, polyethylene-epoxy resin, polyamide-unsaturated polyester and silicone rubber-epoxy resin.

The storage panel of the present invention may have a structure as shown in schematic sectional view in Figs. 22A and 22B such that edge portions of the stimuable layer are sealed with a sealing medium comprising an elastomer having moistureproof characteristics and low modulus of elasticity (hereinafter abbreviated to "elastic sealing medium").

In Figs. 22A and 22B 1 is a protective layer, 2 is an intermediate layer, 3 is a stimuable layer, 4 is a support, 10 is an elastic sealing medium and 5 is a protective layer supporting member.

The storage panel has, as shown in Fig. 22A, on a support 4, a stimuable layer 3, an intermediate layer 2 and a protective layer 1 in this order. Edge portions of the stimuable layer 3 are sealed with an elastic sealing medium 10 as shown in Fig. 9. By sealing with this elastic sealing medium 10, the stimuable layer 3 is shut out from the outer atmosphere so that permeation of water is prevented. Further included in the storage panel of the present invention shown in Fig. 22B is the embodiment having a protective layer, supporting member 5 provided at edge portions of the stimuable layer 3 and edge portions of the protective layer supporting member 5 sealed with an elastic sealing medium 10.

The elastic sealing medium 10 comprises an elastomer having moisture resistance and a low modulus of elasticity. Elastomers which can prevent permeation of water from the outside, and absorb warpage or strain due to the difference of thermal expansion coefficients between the support and the protective layer caused by heat during preparation steps or temperature change at the time of using the storage panel so that no damage is caused to the stimuable layer are preferred.

The moisture permeability of the elastomer when sealing the storage panel is preferably  $20 \text{ g/m}^2 \cdot 24 \text{ hr}$  or less, more preferably  $10 \text{ g/m}^2 \cdot 24 \text{ hr}$  or less.

The modulus of elasticity mentioned in the present invention means the longitudinal modulus (Young's

modulus); the modulus of elasticity of the elastomer constituting the above elastic sealing medium is preferably 100 kg/mm<sup>2</sup> or less, more preferably 10 kg/mm<sup>2</sup> or less.

As such elastic sealing media, there may be mentioned, for example, low-density polyethylene, soft epoxy resin, natural rubber, propylene rubber, styrene rubber, butadiene rubber, silicone rubber, fluorine rubber, butadiene-styrene rubber, butadiene-acrylonitrile rubber, isoprene rubber, chlorosulfonated polyethylene rubber, isobutylene rubber, isobutylene-isoprene rubber, acrylic rubber, polysulfide synthetic rubber and urethane rubber.

Sealing of a support and a protective layer of a storage panel by the above elastic sealing medium may be carried out by pouring a liquid sealing medium into a void formed by the support and the protective layer and then solidifying the sealing medium. Alternatively an elastic sealing medium which has previously been molded into a sheet shape can be used.

The width of the elastic sealing medium is determined mainly in connection with the moisture resistance at the adhered portion of the medium with the support and the protective layer. It is preferably from 1 to 30 mm. The width of the elastic sealing medium is preferably not too small due to points of stability, strength and moisture resistance of the elastic sealing medium. It is preferably not too large since the storage panel is then unnecessarily large. The moisture permeability at the adhered portion of the elastic sealing medium with the support and the protective layer is preferably 20 g/m<sup>2</sup>·24 hr or less.

It is necessary to adhere the elastic sealing medium to the support and the protective layer in order to provide moisture resistance to the storage panel. In order to adhere the elastic sealing medium to the support and the protective layer, when the elastic sealing medium is, for example, a sheet shape an adhesive member is, for example, used as shown in Fig. 5. Adhesive members having moisture resistance are preferred. More specifically, there may be employed an organic polymer series adhesive agent such as an epoxy series resin, a phenol series resin, a cyanoacrylate series resin, a vinyl acetate series resin, a vinyl chloride series resin, a polyurethane series resin, an acrylic series resin, an ethylenevinyl acetate series resin, a polyolefin series resin, a chloroprene series rubber or a nitrile series rubber, or a silicone series adhesive agent.

In the storage panel of the present invention, as shown in Fig. 22B, the protective layer supporting member may be a constituting element. This is preferred since a refractive index layer can be provided as in the embodiment shown in Fig. 3. When the protective layer supporting member is provided as mentioned above, sealing by an elastic sealing medium is effected at edge portions of the protective layer supporting member as shown in Fig. 22B.

As the protective layer supporting member, materials having moisture resistance and/or an elastic property as in the elastic sealing medium are preferred. A glass, ceramic, and various polymer sheets may, for example, be mentioned. When the protective layer supporting member has an insufficient elastic property, the protective layer supporting member is preferably not adhered and fixed to both the support and the protective layer at the same time.

The elastic sealing medium may, for example, have a shape as shown in Fig. 23. It may have various shapes such that a part of the elastic sealing medium is an elastic sealing medium 10a (a sealing medium having a low modulus of elasticity) and the other part is a non-elastic sealing medium 10b (a sealing medium having a high modulus of elasticity).

An example of a process for preparing a storage panel will now be explained.

First, after forming a stimuable layer on a support by a coating method or a vapor phase build-up method, a protective layer supporting member is adhered onto the support by an adhesive agent so as to surround the stimuable layer. Next, one end of the protective layer supporting member (the opposite portion to the adhered portion of the support) is similarly adhered to the protective layer. By carrying out the chain of steps in a normal atmosphere, an intermediate layer which is a lower refractive index layer consisting of air can be made. By injecting a liquid from a void provided at a part of the protective layer or by making a vacuum, the intermediate layer can also be made into a liquid layer or a vacuum layer.

Other examples of processes for preparing a storage panel will now be given.

First, after forming a stimuable layer on a support by a vapor phase build-up method such as a vacuum deposition method, a first moistureproof member is adhered onto the support by an adhesive agent so as to surround the stimuable layer. Next, one end of the first moistureproof member (the opposite portion to the adhered portion of the support) is similarly adhered to the protective layer. Thereafter, by filling a second moistureproof member as shown in Fig. 6, a storage panel can be obtained.

Another method which may be applied is one in which after a first moistureproof member is adhered onto a support (or a protective layer) with an adhesive agent, a second moistureproof member is provided at the outside of the first moistureproof member, and then a protective layer (or a support) is covered thereon and adhered thereto.

A process for preparing a storage panel may also be one in which a notch which functions as a vent hole is formed on a protective layer and, after heating and drying the radiation image storage panel, the notch is sealed closed.

Fig. 13 and Fig. 14 schematically show one example of a storage panel prepared according to the present invention wherein 1 is a protective layer, 2 is an intermediate layer, 3 is a stimuable layer, 4 is a support, 5 is a protective layer supporting member and 6 is a sealing medium which seals a notch.

A notch in a spacer may be present at any portion of the spacer and may be any position, but preferably in 1 or 2 positions. The width of the notch may vary depending on the size of the storage panel and numbers of notch(es), but it is suitably selected from 2 to 40 mm. If the width is too narrow, drying is not sufficiently carried out. On the other hand, if it is too wide sealing or closure with an adhesive agent becomes difficult and the durability is lowered.

Heating and drying are carried out at 40 to 100 °C for 0.1 to 3 hours, preferably under reduced pressure which gives a high moistureproof effect.

Immediately after heating and drying, the notch(es) is/are sealed closed using, for example, the above adhesive agent. It is preferred that air in the inner portion of the storage panel is replaced with a dried gas since the initial characteristics of the storage panel can be improved. It is also preferred that sealing of the notch(es) is carried out in a dried gas atmosphere since permeation of water from the notch(es) can be prevented.

Since the inner portion of the radiation image storage panel prepared according to the present invention is maintained in a dried state, the stimuable layer hardly deteriorates and the initial characteristics can be improved.

In the present invention, it is preferred that a dried gas is encapsulated between the support and the protective layer. A preferred dried gas is an inert gas such as He, Ne or Ar, or, for example, O<sub>2</sub>, H<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub> or air. These gases may be used singly or in combination of two or more. Preferred are an inert gas and N<sub>2</sub>.

The moisture content of the dried gas is 5.0 mg/l or less, preferably 0.2 mg/l or less, more preferably 0.02 mg/l or less.

The pressure of the dried gas is preferably slightly higher than that used by the storage panel in order to avoid permeation of water from the outside into the storage panel.

The dried gas is, for example, as shown in Figs. 13 to 16, encapsulated between a support and a protective layer. It is preferred that a protective layer which is thick and has low moisture permeability is used. A dried gas is present between the stimuable layer and a protective layer to form an intermediate lower refractive index layer since both moisture resistance and sharpness are excellent.

It is preferred, as shown in Fig. 17, that a spacer (a protective layer supporting member 5) is provided.

In the storage panel of the present invention, in order to encapsulate a dried gas, for example, the following method can be employed.

After a storage panel comprising a support, a stimuable layer and a protective layer is formed according to any of the above-mentioned methods, when sealing its edges with a sealing medium, one vent hole (notch) is provided at the portion to be sealed. After sucking to create a vacuum, the dried gas is introduced into the inner portion and the vent hole is sealed. It is preferred that the suction to create the vacuum be carried out with heating since the elimination of water can be carried out effectively. By connecting the notch portion direct to a vacuum line and then sealing by cutting the connecting line after replacement with the dried gas, permeation of water can also be prevented more effectively.

Another method which can be employed is one in which two or more notches are formed in the sealing portion, a dried gas is introduced through one notch and is passed through the storage panel, replacement is effected with the dried gas, and then the notches are sealed. It is preferred that the above procedure also be carried out with heating since permeation of water can be prevented more effectively.

If a dried gas is encapsulated in the storage panel, the inside of the storage panel is maintained in the dried state and the pressure therein is maintained higher than the external pressure so that water hardly permeates from a protective layer or a sealed portion of the edges.

In the radiation image storage panel of the present invention, when the edge portions are sealed with a sealing medium, it is more effective to provide a hygroscopic agent between the support and the protective layer.

Fig. 18 shows one example of a storage panel of the present invention; 1 is a protective layer, 3 is a stimuable layer, 4 is a support, 8 is a sealing medium and 9 is a hygroscopic agent,

Examples of the hygroscopic agent are silica gel, CaCl<sub>2</sub> and LiCl, or an organic polymer compound having high hygroscopicity such as a polyvinyl alcohol or ethylene-vinyl alcohol copolymer. These may be used as they are, after molding or after being added into a resin.

The hygroscopic agent may be employed in an amount such that water hygroscopic content is from 0.1 to 50 mg per one gram of stimutable phosphor.

The hygroscopic agent may be present at any position so long as it exists between the support and a protective layer, excluding the case in which it exists between the stimutable layer where an image is provided by converting accumulated X-ray energy and a protective layer. The hygroscopic agent may be present continuously or discontinuously. The preferred state is that in which the hygroscopic agent is present between the support and a protective layer and is filled between the outside portion of a stimutable layer and a sealing medium without gaps.

When an intermediate lower refractive index layer comprising a gaseous layer is provided, as shown in Fig. 20, a spacer may be provided between a protective layer and a support in order to retain a space between a stimutable phosphor layer and a protective layer.

Since a hygroscopic agent is incorporated in this radiation image storage panel, water permeated from a sealing portion of the edges of the storage panel can be absorbed and eliminated. Water contained in the stimutable layer at the time of preparation of the storage panel can also be absorbed and eliminated. Thus the initial characteristics can be improved without deterioration of the stimutable layer by water.

Therefore, according to the present invention, there can be provided a storage panel which has excellent characteristics even when it is used under severe temperature and humidity conditions even using a stimutable phosphor which has low humidity resistance.

The stimutable phosphors constituting the stimutable layer of the storage panel according to the present invention include phosphors which emit, after irradiation by an initial light or high energy radiation source, a stimulation (stimulating excitation) of an optical, thermal, mechanical, chemical or electrical nature in response to the irradiation dose of the initial light or high energy radiation source. For such reasons, in practical use, stimutable phosphors which can exhibit stimulated emission with a stimulating excitation light at 500 nm or more are preferred. Such stimutable phosphors include, for example, those disclosed in Japanese Provisional Patent Publication No. 80487/1973 represented by the formula  $\text{BaSO}_4:\text{Ax}$ ; those disclosed in Japanese Provisional Patent Publication No. 80489/1973 represented by the formula  $\text{SrSO}_4:\text{Ax}$ ; those disclosed in Japanese Provisional Patent Publication No. 39277/1978 represented by, for example, the formula  $\text{Li}_2\text{B}_4\text{O}_7:\text{Cu,Ag}$ ; those disclosed in Japanese Provisional Patent Publication No. 47883/1979 represented by, for example, the formulae  $\text{Li}_2\text{O}^*(\text{B}_2\text{O}_3)_x:\text{Cu}$  and  $\text{Li}_2\text{O}^*(\text{B}_2\text{O}_3)_x:\text{-Cu,Ag}$ ; and those disclosed in U.S. Patent No. 3,859,527 represented by the formulae  $\text{SrS}:\text{Ce,Sm}$ ,  $\text{SrS}:\text{Eu,Sm}$ ,  $\text{La}_2\text{O}_3\text{S}:\text{Eu,Sm}$  and  $(\text{Zn,Cd})\text{S}:\text{Mn,X}$ .

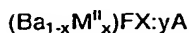
There may also be used, as disclosed in Japanese Provisional Patent Publication No. 12142/1980, a  $\text{ZnS}:\text{Cu,Pb}$  phosphor, a barium aluminate phosphor represented by the formula:  $\text{BaO}^*\text{xAl}_2\text{O}_3:\text{Eu}$ , and an alkaline earth metal silicate type phosphor represented by the formula:  $\text{M}^{II}\text{xSiO}_2:\text{A}$ ; an alkaline earth fluorohalogenated phosphor represented by the formula:



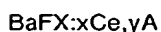
as disclosed in Japanese Provisional Patent Publication No. 12143/1980; a phosphor represented by the formula:



as disclosed in Japanese Provisional Patent Publication No. 12144/1980; a phosphor represented by the formula:



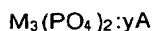
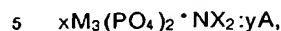
as disclosed in Japanese Provisional Patent Publication No. 12145/1980; a phosphor represented by the formula:



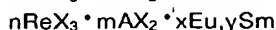
as disclosed in Japanese Provisional Patent Publication No. 84389/1980; a rare earth element activated divalent metal fluorohalide phosphor represented by the formula:



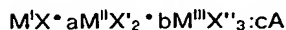
as disclosed in Japanese Provisional Patent Publication No. 160078/1980; phosphors represented by the formulae:  $\text{ZnS:A}$ ,  $\text{CdS:A}$ ,  $(\text{Zn,Cd})\text{S:A}$ ,  $\text{ZnS:A,X}$  and  $\text{CdS:A,X}$ ; a phosphor represented by either one of the formula:



as disclosed in Japanese Provisional Patent Publication No. 38278/1984; a phosphor represented by either  
10 one of the formula:



15 as disclosed in Japanese Provisional Patent Publication No. 155487/1984; an alkali halide phosphor represented by the formula:



20 as disclosed in Japanese Provisional Patent Publication No. 72087/1986; and a bismuth activated alkali halide phosphor represented by the formula:



25 as disclosed in Japanese Provisional Patent Publication No. 228400/1986. Alkali halide phosphors are preferred since a stimuable layer is easily formed by methods such as vapor evaporation or sputtering.

However, the stimuable phosphor which may be used in the radiation image storage panel of the present invention is not limited to those described above; any phosphor which can exhibit stimulated fluorescence when irradiated with a stimulating excitation light after irradiation of radiation may be used.

30 Since permeation of water from the outside is prevented in the storage panel of the present invention, an alkaline earth fluorohalide phosphor, or an alkali halide phosphor, for example, which are normally easily deteriorated by water, may be used as the phosphor so that the effect of the present invention is great.

The stimuable layer of the storage panel of the present invention may have a group of stimuable phosphor layers containing one or more stimuable phosphor layers comprising at least one of the  
35 stimuable phosphors as mentioned above. The stimuable phosphor contained in the respective stimuable phosphor layers may be either identical or different.

As the method for forming the stimuable layer, a coating method as disclosed in Japanese Provisional Patent Publication No. 12600/1981 may be applied, or a gas phase build-up method such as a vapor evaporation method may be applied.

40 The stimuable layer formed by a gas phase build-up method has high packing density and high radiation sensitivity as compared with a stimuable layer formed by a coating method.

The thickness of the stimuable phosphor layer in the storage panel differs depending on, for example, the sensitivity of the panel to radiation and the kind of stimuable phosphor. It is preferably from 10 to 1000  $\mu\text{m}$ , more preferably from 30 to 800  $\mu\text{m}$  when no binder is used, and preferably from 20 to 1000  $\mu\text{m}$ , more  
45 preferably from 50 to 500  $\mu\text{m}$  when a binder is used.

Examples of the support are various polymers, glass, ceramic and metal.

Acceptable polymers include a film such as cellulose acetate, polyester, polyethylene terephthalate, polyamide, polyimide, triacetate, or polycarbonate. Acceptable metals include a metal sheet or a metal plate such as aluminium, iron, copper or chromium or a metal sheet or a metal plate having a coating layer of an  
50 oxide of the metal. Acceptable glasses include a chemically reinforced glass or a crystallized glass. Acceptable ceramics include a sintered plate of alumina and zirconia.

The layer thickness of these supports depends on, for example, the material quality of the support. It is generally from 80  $\mu\text{m}$  to 5 mm, more preferably from 200  $\mu\text{m}$  to 3 mm from the viewpoint of handling. The layer thickness of the support is preferably such that the moisture permeability is 10  $\text{g/m}^2 \cdot 24 \text{ hr}$ , more  
55 preferably 5  $\text{g/m}^2 \cdot 24 \text{ hr}$  or less.

The surface of these supports may be smooth or matt in order to improve adhesiveness with a stimuable layer. The surface of these supports may also be a concave-convex surface, or may have a surface structure in which separate and independent fine tile plates are closely disposed.



To improve the adhesion between the support and the phosphor layer, these supports may be provided with a subbing layer on the surface on which the phosphor layer is provided, or if necessary, a light reflective layer or a light absorbing layer may, for example, be provided.

As disclosed in Japanese Provisional Patent Publication No. 220492/1986, a radiation image storage panel original body comprising a support and a stimuable layer may be contained in a protective bag comprising a polymer film and the side edges may be sealed. In this case, an intermediate lower refractive index layer may previously be formed on the surface of the stimuable layer or may be formed on the surface opposite the stimuable layer in the protective bag. An intermediate lower refractive index layer may be formed by providing a gaseous layer or a vacuum layer between the protective layer and the stimuable layer.

A heat sealing method, a high frequency sealing method and ultrasonic sealing method are preferred for sealing the protective bag, but an adhesive agent, contact bonding or thermal contact bonding may be used.

In the storage panel of the present invention, the protective layer may also have the role of a support. In this case, the support mentioned in this invention does not necessarily have to have the function of supporting a stimuable layer.

The storage panel of the present invention may be employed in the radiation image storage method schematically illustrated in Fig. 21.

In Fig. 21, 41 is a radiation generator, 42 is a subject, 43 is a storage panel according to the present invention, 44 is a stimulating excitation light source, 45 is a photoelectric transducer to detect stimulated emission radiated from the panel, 46 is a unit to reproduce as an image the signals detected by 45, 47 is a unit to display a reproduced image, and 48 is a filter to separate the stimulating excitation light and stimulated emission, passing only the stimulated emission. 45 and thereafter are not limited by the above so long as they can reproduce optical information from 43 as an image in any form.

Radiation from the radiation generator 41 is applied to the panel of the present invention through the subject 42. This radiation is absorbed in the phosphor layer of the panel 43, where its energy is accumulated to form an accumulated image of the radiation-transmitted image.

This accumulated image is then excited by the stimulating excitation light from the stimulating excitation light source 44 and emitted as stimulated emission.

The strength of the stimulated emission is proportional to the amount of accumulated radiation energy. Accordingly, this light signal may be subjected to photoelectrical conversion by the photoelectric transducer 45 as exemplified by a photomultiplier tube, reproduced as an image by the image-reproducing unit 46, and displayed by the image display unit 47, so that the radiation-transmitted image of the subject can be observed.

The present invention is now further explained in the following Examples.

#### Example 1

On a crystallized glass support having a thickness of 500  $\mu\text{m}$ , an alkali halide phosphor (RbBr:0.0006Tl) was vapor evaporated with a thickness of 300  $\mu\text{m}$  using a vapor evaporation device.

Subsequently, on the above stimuable layer, a protective layer having a thickness of 550  $\mu\text{m}$  and an intermediate lower refractive index layer were provided as a combination shown in Table 5 wherein the numerals in parentheses are the refractive index.

Table 5

Layer Sample	Protective layer	Lower refractive index layer
1	Glass (1.52) 550 $\mu\text{m}$	CaF <sub>2</sub> (1.25) 0.1 $\mu\text{m}$
2	Glass (1.52) 550 $\mu\text{m}$	Air (1.0) 200 $\mu\text{m}$
3	Glass (1.52) 550 $\mu\text{m}$	Air (1.0) 10 $\mu\text{m}$
4	PET (1.54) 550 $\mu\text{m}$	Air (1.0) 10 $\mu\text{m}$

#### Example 2



On a crystallized glass support having a thickness of 500  $\mu\text{m}$ , an alkali halide phosphor (RbBr:0.0006T1) was vapor evaporated with a thickness of 300  $\mu\text{m}$  using a vapor evaporation device.

Subsequently, on the above stimuable layer, a protective layer having a thickness of 550  $\mu\text{m}$ , an intermediate lower refractive index layer and a higher refractive index layer were provided by the combination as shown in Table 6 wherein the numerals in parentheses are the refractive index.

Table 6

Layer Sample	Protective layer	Lower refractive index layer	Higher refractive index layer
5	Glass (1.52) 550 $\mu\text{m}$	$\text{CaF}_2$ (1.25) 0.1 $\mu\text{m}$	$\text{ZrO}_2$ (2.1) 0.1 $\mu\text{m}$
6	Glass (1.52) 550 $\mu\text{m}$	Air (1.0) 200 $\mu\text{m}$	PET (1.54) 10 $\mu\text{m}$
7	Glass (1.52) 550 $\mu\text{m}$	Air (1.0) 10 $\mu\text{m}$	PET (1.54) 10 $\mu\text{m}$
8	PET (1.54) 550 $\mu\text{m}$	Air (1.0) 10 $\mu\text{m}$	PET (1.54) 10 $\mu\text{m}$

After formation of the stimuable layer in Samples Nos. 2 to 4, and after formation of the intermediate lower refractive index layer in Samples Nos. 6 to 8, a glass sheet having a width of 5 mm was adhered and formed on the support so as to surround the above stimuable layers. This glass sheet layer was selected such that the thickness of the lower refractive index layer was as shown in Tables 5 and 6. After vacuum drying, other surfaces of the above glass sheet and the protective layers shown in Table 5 were provided to Samples Nos. 2 to 4, respectively, in the same manner as mentioned above.

#### Comparative example 1

As a comparative example, using the same support and stimuable layer, comparative samples A and B were prepared by adhering protective layers to the stimuable layer with a polyurethane type adhesive agent as shown in Table 7 without providing an intermediate lower refractive index layer and higher reflective index layer.

Table 7

A	B
PET 10 $\mu\text{m}$	Glass 550 $\mu\text{m}$

In each of samples, vacuum drying was carried out at 80 °C and 0.13 Pa ( $10^{-3}$  Torr) for one hour. The moistureproof properties and sharpness by MTF were checked for the above samples.

Samples Nos. 1, 2, 3, 5, 6 and 7 and Comparative sample B showed good moistureproof properties and had no lowering in radiation sensitivity even when they had been allowed to stand at a temperature of 40 °C and 90% humidity for 48 hours. Reduction of accumulated energy until stimulated by stimuable light irradiation was extremely small.

In Samples Nos. 4 and 8, slight deterioration was noted but they are practically acceptable. In Sample A, reduction in accumulated energy until stimulated was extremely large and is a serious problem for practical use.

In Table 8, MTF values at spatial frequencies of 1 lp/mm and 2 lp/mm of each sample are shown. While Comparative Sample B has remarkably lowered sharpness by providing a glass protective layer having a thickness of 550  $\mu\text{m}$ , Samples 1 to 8 show little lowering in sharpness even though they have the same thick protective layer as Comparative Sample B.

Particularly, in Samples Nos. 2 to 4 and 6 to 8, the sharpnesses are the same as that of Comparative Sample A which has the thin protective layer and has high sharpness; Thus they can be put to clinical use.

Table 8

Sample	MTF (%)	
	1 lp/mm	2 lp/mm
1	57	28
2	62	34
3	66	36
4	64	38
5	59	29
6	64	34
7	67	37
8	65	38
A	64	35
B	41	20

Example 3

On a crystallized glass support having a thickness of 500  $\mu\text{m}$ , an alkali halide phosphor (RbBr:0.0006T1) was vapor evaporated with a thickness of 300  $\mu\text{m}$  using a vapor evaporation device.

Subsequently, on the above stimuable layer, a protective layer and an intermediate lower refractive index layer were provided as a combination as shown in Table 9, wherein the numerals in parentheses are the refractive index.

The protective layers in Table 9 had been formed by adhering two protective layers having different absorption permeabilities with an adhesive agent.

Eval EFF in Table 9 is the tradename of an ethylene-vinyl alcohol copolymer (produced by Kuraray Co.); the amount of copolymerized ethylene is 32 mole %.

Comparative example 2

As a comparative example, using the same support and stimuable layer, comparative samples A, B and C were prepared by adhearing protective layers to the stimuable layer with a polyurethane type adhesive agent as shown in Table 10 without providing an intermediate lower refractive index layer and a higher refractive index layer.

Table 9

Layer Sample	Protective layer	Lower refractive index layer
9	Glass (1.52) 550 $\mu\text{m}$ + Eval EFF (1.50) 15 $\mu\text{m}$	Air (1.0)
10	PET (1.54) 550 $\mu\text{m}$ + Eval EFF (1.50) 15 $\mu\text{m}$	Air (1.0)
11	Polyethylene (1.55) 80 $\mu\text{m}$ + Eval EFF (1.50) 15 $\mu\text{m}$	Vacuum (1.0)
12	Polyethylene (1.55) 80 $\mu\text{m}$ + Stretched Nylon (1.50) 15 $\mu\text{m}$	Vacuum (1.0)

Table 10

Layer Sample	Protective layer	Lower refractive index layer
A	PET (1.54) 10 $\mu\text{m}$	None
B	Glass (1.52) 550 $\mu\text{m}$	None
C	Polyethylene (1.55) 80 $\mu\text{m}$	None

In each of the samples, after the stimuable layer vacuum evaporated on the support was vacuum dried at 80 °C and 0.13 Pa ( $10^{-3}$  Torr) for one hour, the edges thereof were sealed. In Samples Nos. 9 and 10, as shown in Fig. 4, Eval EFF was provided on the stimuable layer side, an air layer of 100  $\mu\text{m}$  thickness was provided between the stimuable layer and the protective layer by providing a glass spacer having a 400  $\mu\text{m}$  thickness, and edges of the protective layer and the support were sealed with an epoxy resin type adhesive agent.

In Samples Nos. 11 and 12, the support on which the stimuable layer had been vacuum evaporated was contained in a protective bag with polyethylene on the outside, and vacuum sealed.

#### Comparative example 3

Comparative samples A, B and C were prepared by adhering the protective layer to the stimuable layer and the edges of the protective layer and the support were sealed with an epoxy resin type adhesive agent.

The moistureproof property and sharpness by MTF of the above samples were checked.

Samples Nos. 9, 10, 11 and 12 and Comparative sample B showed good moisture resistances and had no lowering in radiation sensitivity even when they had been allowed to stand at a temperature of 40 °C and 90% humidity for 48 hours. Reduction of accumulated energy until stimulated by stimuable light irradiation was extremely small.

In Comparative Samples A and C, reduction in accumulated energy until stimulated was extremely large and is a serious problem for practical use.

In Table 11, MTF values at spatial frequencies of 1 lp/mm and 2 lp/mm of each sample are shown. While Comparative Samples B and C have remarkably lowered sharpness by providing a relatively thick protective layer, Samples 9 to 12 show little lowering in sharpness even though they have a thick protective layer.

Samples Nos. 9 to 12 each have a sharpnesses which is the same as or superior to that of Comparative Sample A which had the thin protective layer and had high sharpness. These samples further have excellent humidity resistance.

Table 11

Sample	MTF (%)	
	1 lp/mm	2 lp/mm
9	66	36
10	64	37
11	70	38
12	69	38
A	64	35
B	41	20
C	46	37

#### Example 4

On a crystallized glass support having a thickness of 500  $\mu\text{m}$ , an alkali halide phosphor (RbBr:0.0006T1) was vapor evaporated with a thickness of 300  $\mu\text{m}$  using a vapor evaporation device.

Subsequently, on the above stimuable layer, a protective layer having a thickness of 550  $\mu\text{m}$  and, an intermediate lower refractive index layer and a higher refractive index layer were provided as a combination shown in Table 12 wherein the numerals in parentheses are the refractive index.

Table 12

Layer Sample	Protective layer	Lower refractive index layer	Higher refractive index layer
13	Glass (1.52) 550 $\mu\text{m}$	Air (1.0) 75 $\mu\text{m}$	Eval EFF (1.50) 15 $\mu\text{m}$
14	Glass (1.52) 550 $\mu\text{m}$	Air (1.0) 75 $\mu\text{m}$	PET (1.54) 15 $\mu\text{m}$
15	PRT (1.54) 550 $\mu\text{m}$	Air (1.0) 75 $\mu\text{m}$	Eval EFF (1.50) 15 $\mu\text{m}$
16	PET (1.54) 550 $\mu\text{m}$	Air (1.0) 75 $\mu\text{m}$	PET (1.54) 15 $\mu\text{m}$

Eval EFF in Table 12 is the tradename of an ethylene-vinyl alcohol copolymer (produced by Kuraray Co.) and the amount of copolymerized ethylene is 32 mole %. The equilibrium moisture permeability of the Eval EFF at 25 °C and a relative humidity of 65 % is 3.9 % and that of PET is 0.2 %.

#### Comparative example 4

As Comparative Samples, Comparative Samples A and B used in Comparative example 1 were used.

In each of samples, after the stimuable layer vacuum evaporated on the support was vacuum dried at 80 °C and 0.13 Pa ( $10^{-3}$  Torr) for one hour, the edges thereof were sealed with an epoxy resin type adhesive agent.

Samples Nos. 13 to 16 were, as shown in Fig. 4, made with the Eval EFF on the stimuable layer side, and an air layer of 75  $\mu\text{m}$  thickness was provided between the higher refractive index layer and the protective layer by providing a glass spacer having a thickness of 400  $\mu\text{m}$ .

The moistureproof properties and sharpness by MTF were checked for the above samples.

Samples Nos. 13, 14 and 15 and Comparative sample B show good moistureproof properties and had no lowering in radiation sensitivity even when they had been allowed to stand at 40 °C and 90% humidity for 48 hours. Reduction in accumulated energy until stimulated by stimuable light irradiation was extremely small. In Sample No. 13 the radiation sensitivity is about 1.3 times that of other Samples.

In Sample 16, slight deterioration was noted but was practically acceptable. In Comparative Sample A, reduction in accumulated energy until stimulated was extremely large and was a serious problem in practical use.

In Table 13, MTF values at spatial frequencies of 1 lp/mm and 2 lp/mm of each sample are shown. While Comparative Sample B has remarkably lowered sharpness by providing a relatively thick protective layer of 530  $\mu\text{m}$  thickness, Samples No. 13 to 16 have little lowering in sharpness even though they have the thick protective layer as Comparative Sample B.

In samples Nos. 13 to 16, the sharpnesses are the same as or superior to that of Comparative Sample A which has a thin protective layer and has high sharpness. They can be put to clinical use. Sample No. 13 has particularly excellent characteristics since it has a higher radiation sensitivity than the others.

Table 13

Sample	MTF (%)	
	1 lp/mm	2 lp/mm
13	66	39
14	66	38
15	67	37
16	65	38
A	65	37
B	40	21

Examples 5 to 7

On a crystallized glass support having a thickness of 500  $\mu\text{m}$ , an alkali halide phosphor (RbBr:0.0006T1) was vapor evaporated with a thickness of 300  $\mu\text{m}$  using a vapor-evaporation device to form a stimuable layer. Subsequently, on the support, a glass sheet having a width of 5 mm was adhered with an epoxy resin type adhesive agent so as to surround the above stimuable layer. This glass sheet had the thickness of the lower refractive index layer shown in Table 14. Then, vacuum drying was carried out at 80 °C and 0.13 Pa ( $10^{-3}$  Torr) for one hour. Next, the other surface of the above glass sheet and the protective layer shown in Table 14 were adhered in the same manner as mentioned above. By effecting the above series of steps in the ambient atmosphere, the intermediate lower refractive index layer was made an air layer to provide a storage panel of the present invention. In Table 14, the numerals in parentheses are the refractive index.

Comparative example 5

As a comparative samples, using the same support and stimuable layer as in the Examples, two kinds of protective layers (PET and glass) were adhered to the stimuable layer with a polyurethane type adhesive agent without providing an intermediate lower refractive index layer. Edges of the stimuable layer were sealed with a glass sheet having a width of 5 mm and an epoxy resin type adhesive agent in the same manner as in Examples 5 to 7. The samples thus formed are called Comparative Samples D and E. Comparative Sample D was prepared to improve mainly the sharpness (that in which the protective layer was PET) and the Comparative Sample E was prepared to improve mainly the moistureproof property (that in which the protective layer was glass).

Table 14

Layer Sample	Protective layer	Lower refractive index layer
Example 5	Glass (1.52) 550 $\mu\text{m}$	Air (1.0) 400 $\mu\text{m}$
Example 6	Glass (1.52) 550 $\mu\text{m}$	Air (1.0) < 10 $\mu\text{m}$
Example 7	PET (1.54) 1.5 mm	Air (1.0) 400 $\mu\text{m}$
Comparative Sample D	PET (1.54) 10 $\mu\text{m}$	None
Comparative Sample E	Glass (1.52) 550 $\mu\text{m}$	None

Examples 8 to 13

Storage panels of the present invention were prepared in the same manner as in Examples 5 to 7 except for using a protective layer and a protective layer supporting member as shown in Table 15.

Table 15

Layer Sample	Protective layer	Lower refractive index layer	Protective layer supporting member
Example 8	Glass (1.52) 1 mm	Air (1.0) 1 mm	Glass width 5 mm
Example 9	OPP 1.5 mm	Air (1.0) 2 mm	Glass width 3 mm
Example 10	Glass 1 mm	Air (1.0) 2 mm	Polyethylene width 8 mm
Example 11	Polyethylene 2.5 mm	Air (1.0) 1 mm	Acryl resin width 10 mm
Example 12	Acryl resin 3.5 mm	Air (1.0) 1 mm	Acryl resin width 10 mm
Example 13	Glass (1.52) 1 mm	Nitrogen (1.0) 1 mm	Glass width 5 mm

#### Examples 14 and 15

Storage panels of the present invention were prepared in the same manner as in Example 13 except for using a phenol resin type adhesive agent (Example 14) and a silicone resin type adhesive agent (Example 15) as adhesive agents

#### Examples 16 and 17

8 parts by weight of BaFBr:Eu stimuable phosphor and 1 part by weight of polyvinyl butyral resin were mixed and dispersed using 5 parts by weight of a solvent (cyclohexanone) to prepare a coating solution for forming a stimuable layer. The coating solution was uniformly coated on a levelly placed crystallized glass having a thickness of 500  $\mu\text{m}$  and allowed to dry naturally to form a stimuable layer having a thickness of about 300  $\mu\text{m}$ . Thereafter, on the support, a glass sheet having a width of 5 mm was adhered with an epoxy resin type adhesive agent to surround the above stimuable layer. This glass sheet had the thickness of the intermediate lower refractive index layer shown in Table 16. Then, vacuum drying was carried out at 80 °C and 0.13 Pa ( $10^{-3}$  Torr) for one hour. Next, the other surface of the above glass sheet and the protective layer shown in Table 16 were adhered in the same manner as mentioned above. By effecting the above series of steps in the ambient atmosphere, the intermediate lower refractive index layer was made an air layer to provide a storage panel of the present invention.

#### Comparative example 6

As Comparative Sample F, using the same support and the stimuable layer as in the above Examples, PET was adhered to the stimuable layer with a polyurethane type adhesive agent without forming an intermediate lower refractive index layer. Comparative Sample F was prepared to improve mainly the sharpness.

Table 16

Layer Sample	Protective layer	Lower refractive index layer
Example 16	Glass (1.52) 550 $\mu\text{m}$	Air (1.0) 800 $\mu\text{m}$
Example 17	PET (1.54) 250 $\mu\text{m}$	Air (1.0) 800 $\mu\text{m}$
Comparative Sample F	PET (1.54) 10 $\mu\text{m}$	None

The moistureproof property and sharpness were evaluated for the panels of the above Examples and Comparative examples. The results are shown in Table 17.

The moistureproof property was evaluated from the sensitivity lowering rate and fading lowering rate after forced lowering in which the storage panel was allowed to stand at 40 °C and 95% relative humidity for 60 days. The test methods are as follows:

#### Sensitivity lowering rate P

After 10 mR X-rays having a tube voltage of 80 kVp had been irradiated on a storage panel before a forced deterioration test, and after interval of 5 seconds, stimulating with semiconductor laser light (780 nm, 20 mW) was carried out and stimulated emission was photoelectrically converted by a photomultiplier whereby the sensitivity  $S_{st}$  (5 sec) of the storage panel before the deterioration test was measured from the degree of the obtained electric signal. Also, in the same manner as mentioned above, the sensitivity  $S_{60}$  (5 sec) of the storage panel after the deterioration test was measured.

From obtained each sensitivity, the sensitivity lowering rate was calculated by the following equation:

$$P (\%) = 1 - \frac{S_{60} (5 \text{ sec})}{S_{st} (5 \text{ sec})} \times 100$$

#### 15 Fading lowering rate Q

Fading :  $F_{ST}$  (damping factor of accumulated energy between irradiation of X-rays and reading a signal with a laser beam) of a storage panel before the forced deterioration test was measured by the following method. First after 10 mR X-rays having a tube voltage of 80 kVp had been irradiated on a storage panel, and after an interval of 5 seconds, stimulating with semiconductor laser light (780 nm, 20 mW) was carried out and stimulated emission was photoelectrically converted by a photomultiplier whereby the sensitivity  $S_{st}$  (5 sec) was measured from the degree of the obtained electric signal. Also, in the same manner as mentioned above, the sensitivity  $S_{st}$  (120 sec) was measured from the electric signal obtained by stimulating with an interval of 120 seconds after X-ray irradiation.

From each sensitivity obtained, the fading  $F_{ST}$  before the deterioration test was calculated by the following equation:

$$F_{ST} = 1 - \frac{S_{st} (120 \text{ sec})}{S_{st} (5 \text{ sec})}$$

In the same manner as mentioned above, the fading  $F_{60}$  of the storage panel after a forced deterioration test was calculated by the following equation:

$$F_{60} = 1 - \frac{S_{60} (120 \text{ sec})}{S_{60} (5 \text{ sec})}$$

From the  $F_{ST}$  and the  $F_{60}$  values thus obtained, the fading lowering rate was calculated from the following equation:

$$Q (\%) = \frac{F_{60} - F_{ST}}{1 - F_{ST}} \times 100$$

#### 50 Sharpness

Sharpness was evaluated by measuring the modulation transfer function (MTF) with spatial frequencies of 1 lp/mm and 2 lp/mm with respect to the storage panel before the forced deterioration test.

Table 17

	Sensitivity lowering rate (%)	Fading lowering rate (%)	MTF	
			1 lp/mm	2 lp/mm
Example 5	< 2	< 2	70	38
Example 6	< 2	< 2	71	36
Example 7	18	34	70	37
Example 8	< 2	< 2	70	37
Example 9	4.8	9.8	70	38
Example 10	< 2	2.1	71	38
Example 11	3.4	7.0	70	38
Example 12	11	25	71	37
Example 13	< 2	< 2	70	38
Example 14	< 2	2.5	71	38
Example 15	< 2	2.8	70	37
Example 16	< 2	< 2	65	34
Example 17	5.5	8.3	64	33
Comparative D	94	99	76	36
Comparative E	< 2	< 2	42	20
Comparative F	38	46	64	35

While the storage panels of Examples 5 to 15 in Table 17 have thick protective layers, they have little lowering in sharpness and can be put to clinical use. To the contrary, the storage panel of Comparative Sample E which had a glass layer of a thickness of 550  $\mu\text{m}$  adhered to the stimuable layer had remarkable lowered sharpness. Reduction in the fading lowering rate is small in the storage panels of the Examples and these storage panels have sufficient humidity resistance. On the other hand, since the storage panel of Comparative Sample S had a thin protective layer, deterioration due to water was remarkable and it could not be put to clinical use.

The storage panels of Examples 16 and 17 in Table 17 also have excellent sharpness. The sensitivity lowering rate and fading lowering rate due to the deterioration test thereof are less as compared with that of the storage panel of Comparative Sample F, and these storage panels have sufficient humidity resistance.

#### Examples 18 to 23

On a support shown in Table 18, an alkali halide phosphor ( $\text{RbBr:0.0006Tl}$ ) was vapor evaporated with a thickness of 300  $\mu\text{m}$  using a vapor evaporation device to form a stimuable layer. Subsequently, a first moistureproof member shown in Table 18 and having the same thickness as the stimuable layer was adhered with an epoxy resin type adhesive agent. Thereafter, in the same manner as mentioned above, a protective layer was adhered to the above first moistureproof member. Next, a second moistureproof member shown in Table 18 was filled to prepare a storage panel of the present invention.

The moistureproof property and sharpness of the storage panels were evaluated. The results of the moistureproof property tests are shown in Table 18.

The moistureproof property was evaluated from the sensitivity lowering rate and fading lowering rate after the storage panel was subjected to forced deterioration by allowing it stand at 40 °C and 97% relative humidity for 80 days. The test methods are as mentioned above.

#### Example 24



A storage panel was prepared in the same manner as in Example 18 except for adhering the protective layer and the stimuable layer with a polyurethane type adhesive agent. The same tests were carried out as in Examples 18 to 23. The results are shown in Table 18.

5    Example 25

A storage panel was prepared in the same manner as in Example 18 except for forming the stimuable layer by the method below:

8 parts by weight of BaFBr:Eu phosphor having an average particle size of 2  $\mu\text{m}$  and 1 part by weight  
10 of polyvinyl butyral (binder) were mixed and dispersed using 5 parts by weight of a solvent (cyclohexanone) to prepare a coating solution. Subsequently, the coating solution was uniformly coated on a levelly placed support which was the same as in Example 18 and was allowed to stand for a day and night to form a stimuable layer.

The same tests were carried out as in Examples 18 to 23. The results are shown in Table 18.

15

Example 26

A storage panel was prepared in the same manner as in Example 19 except that the thickness of the first moistureproof member was made thicker than the stimuable layer as shown in Table 18. The same  
20 tests were carried out as in Examples 18 to 23. The results are shown in Table 18.

Example 27

A storage panel was prepared in the same manner as in Example 23 except that the thickness of the  
25 first moistureproof member was made thicker than the stimuable layer as shown in Table 18. The same tests were carried out as in Examples 18 to 23. The results are shown in Table 18.

Comparative example 7

30 Storage panels G and H were prepared in the same manner as in Examples 17 to 23 except for using only a second moistureproof member as the moistureproof member. The same tests were carried out as in Examples 18 to 23. The results are shown in Table 18.

Comparative example 8

35

A storage panel I was prepared in the same manner as in Examples 18 to 23 except that RbBr:Tl was used as the phosphor, the stimuable layer was formed by a coating method and polyethylene terephthalate having a thickness of 10  $\mu\text{m}$  was used as the protective layer. The same tests were carried out as in  
40 Examples 18 to 23. The results are shown in Table 18.

45

50

55

Table 18

	Protective layer	First moistureproof member	Second moisture-proof member	Sensitivity lowering rate (%), after 80 days	Fading lowering rate (%), after 80 days
Example 18	Chemically reinforced glass, 200 $\mu$ m thickness	Glass, 300 $\mu$ m thickness, 5 mm width	Epoxy resin 5 mm width	< 2	< 2
Example 19	Chemically reinforced glass, 1 mm thickness	Glass, 300 $\mu$ m thickness, 5 mm width	Epoxy resin 5 mm width	< 2	< 2
Example 20	Oriented polypropylene 2 mm thickness	Glass, 300 $\mu$ m thickness, 5 mm width	Epoxy resin 7 mm width	5.1	10
Example 21	Chemically reinforced glass, 1 mm thickness	Acrylic resin 300 $\mu$ m thickness 8 mm width	Epoxy resin 4 mm width	3.8	6.2
Example 22	Chemically reinforced glass, 1 mm thickness	Alumina, 300 $\mu$ m thickness, 5 mm width	Polyvinyl chloride 7 mm width	< 2	< 2
Example 23	Chemically reinforced glass, 1 mm thickness	Polyvinyl chloride 300 $\mu$ m thickness 5 mm width	Silicone resin 8 mm width	4.2	7.5

Table 18 (Contd)

	Protective layer	First moistureproof member	Second moistureproof member	Sensitivity lowering rate (%), after 80 days	Fading lowering rate (%), after 80 days
Example 24	Chemically reinforced glass, 200 $\mu$ m thickness	Glass, 300 $\mu$ m thickness, 5 mm width	Epoxy resin 5 mm width	< 2	< 2
Example 25	Chemically reinforced glass, 200 $\mu$ m thickness	Glass, 300 $\mu$ m thickness, 5 mm width	Epoxy resin 5 mm width	< 2	< 2
Example 26	Chemically reinforced glass, 1 mm thickness	Glass, 500 $\mu$ m thickness, 5 mm width	Epoxy resin 5 mm width	< 2	< 2
Example 27	Chemically reinforced glass, 1 mm thickness	Polyvinyl chloride 400 $\mu$ m thickness 5 mm width	Silicone resin 8 mm width	5.1	8.8
Comparative G	Chemically reinforced glass, 200 $\mu$ m thickness	None	Epoxy resin 5 mm width	31	38
Comparative H	Chemically reinforced glass, 1 mm thickness	None	Silicone resin 8 mm width	44	46
Comparative I	Polyethylene terephthalate, 10 $\mu$ m	None	None	98	99

The storage panels of Examples 18 to 27 have little deterioration in initial characteristics even when they are submitted to high temperature and high pressure, and thus they have excellent durability. To the contrary, in the storage panels of Comparative Samples G, H and I, the phosphor deteriorated by permeation of water and their initial characteristics remarkably deteriorated. Since the storage panel of Example 24 had a thick protective layer provided by adhering the stimulative layer and the protective layer

with an adhesive agent, lowering in the sharpness of the images was observed. In the storage panels of Examples 18 to 23, while the stimuable layer and the protective layer are adjacent to each other, lowering in sharpness was not observed since an optically discontinuous face was present.

#### 5 Example 28

8 parts by weight of BaFBr:Eu stimuable phosphor and 1 part by weight of polyvinyl butyral resin were mixed and dispersed using 5 parts by weight of a solvent (cyclohexanone) to prepare a coating solution for forming a stimuable layer. Subsequently, the coating solution was uniformly coated on a levelly placed  
10 crystallized glass having a thickness of 500  $\mu\text{m}$  and was allowed to dry naturally to form a stimuable layer having a thickness of about 300  $\mu\text{m}$ . Thereafter, the above product was contained in a bag of PET film having a thickness of 12  $\mu\text{m}$  and was vacuum laminated with a vacuum laminating machine. By effecting the above series of steps, the intermediate lower refractive index layer was made a vacuum layer to provide a storage panel of the present invention.

15

#### Comparative example 9

As in Comparative Sample J, using the same support and stimuable layer as in the above Examples, PET having a thickness of 10  $\mu\text{m}$  was adhered to the stimuable layer with a polyurethane type adhesive  
20 agent without forming an intermediate lower refractive index layer.

Table 19

25	Sample Layer	Protective layer	Lower refractive index layer
	Example 28	PET (1.54) 12 $\mu\text{m}$	Vacuum (1.0) < 0.1 $\mu\text{m}$
	Comparative Sample J	PET (1.54) 12 $\mu\text{m}$	None

30 The moistureproof property and sharpness of the storage panels of the above Example and Comparative example were evaluated. The results are shown in Table 20.

Table 20

35		Sensitivity lowering rate (%)	Fading lowering rate (%)	MTF	
				1 lp/mm	2 lp/mm
	Example 28	41	56	77	40
40	Comparative J	42	56	62	33

45 As clearly seen from Table 20, in the storage panel of Example 28 of the present invention, lowering in sharpness by providing the protective layer was not observed.

#### Claims

- 50 1. A radiation image storage panel having a stimuable phosphor layer (3), a protective layer (1) and an intermediate layer (2) provided between the stimuable layer (3) and the protective layer (1), on a support (4), characterized in that the intermediate layer (2) has a lower refractive index than the protective layer (1).
- 55 2. A panel according to claim 1, wherein the refractive index of the intermediate layer (2) is substantially 1.
3. A panel according to claim 1, wherein the intermediate layer (2) is a gaseous layer.
4. A panel according to claim 3, wherein the gas contained in the intermediate layer (2) is at least one of

air, nitrogen or argon.

5. A panel according to claim 2, wherein the intermediate layer (2) is a vacuum layer.
- 5 6. A panel according to claim 1, wherein the intermediate layer (2) is a liquid layer.
7. A panel according to claim 6, wherein the liquid contained in the intermediate layer (2) is at least one of ethyl alcohol, methyl alcohol or diethyl ether.
- 10 8. A panel according to any one of claims 3 to 7, wherein the intermediate layer (2) contains a spacer material (6).
9. A panel according to any one of claims 3 to 7, wherein the intermediate layer (2) is formed by providing a protective layer supporting member (5) having a thickness greater than that of the stimuable layer (3) such that the stimuable layer (3) is surrounded by the protective layer supporting member (5).
- 15 10. A panel according to claim 9, wherein the moisture permeability of the protective layer supporting member (5) is  $10 \text{ g/m}^2 \cdot 24 \text{ hr}$  or less.
- 20 11. A panel according to claim 10, wherein the protective layer supporting member (5) comprises at least one of glass, ceramic, metal or plastic.
12. A panel according to any one of claims 9 to 11, wherein the protective layer supporting member (5) is adhered to the support (4) and the protective layer (1) with an adhesive agent.
- 25 13. A panel according to claim 12, wherein the adhesive agent is at least one of an epoxy resin, a phenol resin, a cyanoacrylate resin, a vinyl acetate resin, a vinyl chloride resin, a polyurethane resin, an acrylic resin, an ethylene-vinyl acetate resin, a polyolefin resin, a chloroprene rubber, a nitrile rubber or a silicone resin.
- 30 14. A panel according to any one of claims 9 to 13, wherein the moisture absorption property of the protective layer supporting member (5) is higher than that of the stimuable layer (3).
- 35 15. A panel according to claim 14, wherein said protective layer supporting member (5) comprises at least one of polyvinyl alcohol, ethylene-vinyl alcohol copolymer, polyacrylamide, polyglycine, polymethacrylic acid, polyacrylic acid, polyvinyl pyrrolidone, polyvinyl amine, cellulose diacetate, cellulose triacetate, polyamide, polyvinyl acetate, polymethylallyl alcohol, or a moisture absorbable sheet containing silica gel or calcium carbonate.
- 40 16. A panel according to claim 14 or 15, wherein the outside of the protective layer supporting member (5) is sealed with a sealing member (82) of a low melting point glass.
17. A panel according to claim 9, wherein the protective layer supporting member (5) comprises a first moistureproof member (7a) and a second moistureproof member (7b).
- 45 18. A panel according to claim 17, wherein the first moistureproof member (7a) is provided at the edge portion of the stimuable layer (3) and is adhered to the support (4) and the protective layer (1).
- 50 19. A panel according to claim 17 or 18 wherein the moisture permeability of the first moistureproof member (7a) is  $10 \text{ g/m}^2 \cdot 24 \text{ hr}$  or less.
20. A panel according to claim 19, wherein the first moistureproof member (7a) comprises at least one of chemically reinforced glass; crystallized glass; alumina, zirconia, aluminium, iron, copper, chromium; a metal coated with an oxide of aluminium, iron, copper or chromium; cellulose acetate, polyester, polyethylene terephthalate, polyamide, polyimide, triacetate or polycarbonate.
- 55 21. A panel according to any one of claims 17 to 20, wherein the moisture permeability of the second

moistureproof member (7b) is  $20 \text{ g/m}^2 \cdot 24 \text{ hr}$  or less.

22. A panel according to claim 21, wherein the second moistureproof member (7b) comprises at least one of a resin which cures by mixing two liquids of a two pack-type urethane adhesive agent, a two pack-type modified acrylate adhesive agent, a two pack-type modified acrylic adhesive agent or a two pack-type epoxy adhesive agent to effect a polycondensation reaction or a cross-linking reaction; or a radiation cure type resin which cures by irradiation with an electromagnetic wave or a corpuscular beam which is an X-ray,  $\alpha$ -ray,  $\beta$ -ray,  $\gamma$ -ray, high energy neutron beam, electron beam or ultraviolet ray.
23. A panel according to any one of claims 17 to 22, wherein the elasticity of the first moistureproof member (7a) is lower than that of the second moistureproof member (7b).
24. A panel according to claim 23, wherein the first moistureproof member comprises at least one of cellulose acetate, polyester, polyethylene terephthalate, polyamide, polyimide, triacetate, polycarbonate, polyethylene, epoxy resin, butadiene-styrene rubber, butadiene-acrylonitrile rubber, isoprene rubber, chlorosulfonated polyethylene rubber, isobutylene rubber, isobutylene-isoprene rubber, acrylic rubber, polysulfide synthetic rubber, urethane rubber, natural rubber, propylene rubber, styrene rubber, butadiene rubber, silicone rubber or fluorine rubber.
25. A panel according to claim 17, wherein the combination of the first moistureproof member (7a) and the second moistureproof member (7b) is urethane rubber-polyethylene, polyethylene-epoxy resin, polyamide-unsaturated polyester or silicone rubber-epoxy resin.
26. A panel according to any one of claims 9 to 25, wherein edge portions of the protective layer supporting member (5) are sealed with a sealing agent (10) comprising an elastomer having a humidity resistance and a low elasticity.
27. A panel according to claim 26, wherein the moisture permeability of the elastomer is  $20 \text{ g/m}^2 \cdot 24 \text{ hr}$  under the conditions of sealing the storage panel.
28. A panel according to claim 26 or 27, wherein the elasticity of the elastomer is  $100 \text{ kg/mm}^2$  or less.
29. A panel according to any one of claims 26 to 28, wherein the elastomer comprises at least one of low-density polyethylene, soft epoxy resin, natural rubber, propylene rubber, styrene rubber, butadiene rubber, silicone rubber, fluorine rubber, butadiene-styrene rubber, butadiene-acrylonitrile rubber, isoprene rubber, chlorosulfonated polyethylene rubber, isobutylene rubber, isobutylene-isoprene rubber, acrylic rubber, polysulfide synthetic rubber or urethane rubber.
30. A panel according to any one of claims 9 to 29, wherein the gas contained in the intermediate layer (2) is a dried gas selected from He, Ne, Ar,  $\text{O}_2$ ,  $\text{H}_2$  and  $\text{CO}_2$ .
31. A panel according to claim 30, wherein the water content of the dried gas is  $5.0 \text{ mg/liter}$  or less.
32. A panel according to any one of claims 9 to 31, wherein a hygroscopic agent (9) is provided between the support (4) and the protective layer (1).
33. A panel according to claim 32, wherein the water absorption amount of the hygroscopic agent (9) is  $0.1$  to  $50 \text{ mg per } 1 \text{ g}$  of the stimuable phosphor.
34. A panel according to claim 32 or 33, wherein the hygroscopic agent (9) is at least one of silica gel,  $\text{CaCl}_2$ ,  $\text{LiCl}$ , polyvinyl alcohol or ethylene-vinyl alcohol copolymer.
35. A panel according to claim 1, wherein the intermediate layer (2) is at least one  $\text{CaF}_2$ ,  $\text{Na}_3\text{AlF}_6$ ,  $\text{MgF}_2$  or  $\text{SiO}_2$ .
36. A panel according to any one of the preceding claims, wherein the refractive index of the protective layer (1) is from  $1.4$  to  $2.0$ .

37. A panel according to any one of the preceding claims wherein the moisture permeability of the protective layer (1) is  $10 \text{ g/m}^2 \cdot 24 \text{ hr}$  or less.
38. A panel according to claim 37, wherein the protective layer (1) is at least one of quartz, borosilicate glass, chemically reinforced glass, polyethylene terephthalate, oriented polypropylene or polyvinyl chloride.
39. A panel according to claim 38, wherein the protective layer (1) is at least one of quartz, borosilicate glass or chemically reinforced glass.
40. A panel according to any one of claims 37 to 39, wherein the light transmittance of the protective layer (1) is 80% or more.
41. A panel according to any one of claims 1 to 35, wherein the protective layer (1) comprises two or more layers (1a and 1b) having different moisture absorption properties.
42. A panel according to claim 41, wherein the protective layer (1) comprises a protective layer having a smaller moisture absorption property (1b) on the outside and a protective layer having a larger moisture absorption property (1a) on the side of the stimuable layer (3).
43. A panel according to claim 42, wherein the protective layer having a smaller moisture absorption property (1b) comprises at least one of a plate glass, polyethylene or polytetrafluoroethylene.
44. A panel according to claim 42 or 43, wherein the protective layer having a larger moisture absorption property (1a) comprises polyvinyl alcohol or ethylene-vinyl alcohol copolymer.
45. A panel according to any one of the preceding claims, wherein a higher refractive index layer (2b) having a higher refractive index than the intermediate layer (2a) is provided between the intermediate layer (2a) and the stimuable layer (3).
46. A panel according to claim 45, wherein the higher refractive index layer (2b) comprises at least one  $\text{Al}_2\text{O}_3$ ,  $\text{Sb}_2\text{O}_3$ ,  $\text{CeO}_2$ ,  $\text{CeF}_3$ ,  $\text{La}_2\text{O}_3$ ,  $\text{LaF}_3$ ,  $\text{PbF}_3$ ,  $\text{NdF}_3$ ,  $\text{Pr}_6\text{O}_{11}$ ,  $\text{SiO}$ ,  $\text{SiO}_2$ ,  $\text{TiO}_2$ ,  $\text{ThO}_2$ ,  $\text{ThF}_4$ ,  $\text{ZnS}$  or  $\text{ZrO}_2$ .
47. A panel according to claim 45, wherein the higher refractive index layer (2b) comprises a material having a high moisture absorption property.
48. A panel according to claim 47, wherein the equilibrium moisture absorption rate of the higher refractive index layer (2b) at a temperature of  $25^\circ\text{C}$  and a relative humidity of 65% is 1% or more.
49. A panel according to any one of the preceding claims, wherein the moisture permeability of the support (4) is  $10 \text{ g/m}^2 \cdot 24 \text{ hr}$  or less.
50. A panel according to claim 49, wherein the support (4) comprises at least one of chemically reinforced glass, crystallized glass; alumina, zirconia, aluminium, iron, copper, chromium; a metal coated thereon with an oxide of aluminium, iron, copper or chromium; cellulose acetate, polyester, polyethylene terephthalate, polyamide, polyimide, triacetate or polycarbonate.
51. A process for preparing a panel as defined in any one of claims 9 to 34 or claims 36 to 50 when dependant on any one of claims 9 to 34, which comprises providing the protective layer supporting member (5) between the support (4) and the protective layer (1) so as to surround and seal the edges of the stimuable layer (3), providing at least one notch in the protective layer supporting member (5) which functions as a vent hole, heating and drying the panel, and then sealing the notch or notches.
52. A process according to claim 51, wherein the heating and drying are carried out at from  $40$  to  $100^\circ\text{C}$  for from 0.1 to 3 hours.
53. A process according to claim 51 or 52, wherein the heating and drying are carried out under a reduced

pressure.

54. A process according to any one of claims 51 to 53 wherein the number of said notches is one or two.

55. A process according to any one of claims 51 to 54, wherein the width of the notch is from 2 to 40 mm.

56. A process according to any one of claims 51 to 55, wherein air inside the storage panel is replaced with a dried gas after the heating and drying.

57. A process according to claim 56, wherein the water content of the dried gas is 5.0 mg/liter or less.

58. A process according to claim 56 or 57, wherein the gas is at least one of He, Ne, Ar, O<sub>2</sub>, H<sub>2</sub> or CO<sub>2</sub>.

#### Patentansprüche

15

1. Schirm zum Speichern eines Strahlungsbildes mit einer anregbaren Phosphorschicht (3), einer Schutzschicht (1) und einer Zwischenschicht (2), die zwischen der anregbaren Schicht (3) und der Schutzschicht (1) angeordnet ist, auf einem Träger (4), dadurch gekennzeichnet, daß die Zwischenschicht (2) einen niedrigeren Brechungsindex als die Schutzschicht (1) aufweist.

20

2. Schirm nach Anspruch 1, worin der Brechungsindex der Zwischenschicht (2) im wesentlichen 1 ist.

3. Schirm nach Anspruch 1, worin die Zwischenschicht (2) eine Gasschicht ist.

25

4. Schirm nach Anspruch 3, worin das Gas, das in der Zwischenschicht (2) enthalten ist, mindestens eines ausgewählt aus Luft, Stickstoff oder Argon ist.

5. Schirm nach Anspruch 2, worin die Zwischenschicht (2) eine Vakuumschicht ist.

30

6. Schirm nach Anspruch 1, worin die Zwischenschicht (2) eine Flüssigkeitsschicht ist.

7. Schirm nach Anspruch 6, worin die Flüssigkeit, die in der Zwischenschicht (2) enthalten ist, mindestens eine ausgewählt aus Ethylalkohol, Methylalkohol oder Diethylether ist.

35

8. Schirm nach irgendeinem der Ansprüche 3 bis 7, worin die Zwischenschicht (2) ein Abstandshaltungsmaterial enthält.

9. Schirm nach irgendeinem der Ansprüche 3 bis 7, worin die Zwischenschicht (2) gebildet wird, indem man ein Schutzschicht-stützendes Element (5) mit einer Dicke, die größer ist als die der anregbaren Schicht (3), so anordnet, daß die anregbare Schicht (3) von dem Schutzschicht-stützenden Element (5) umgeben ist.

40

10. Schirm nach Anspruch 9, worin die Feuchtigkeitsdurchlässigkeit des Schutzschicht-stützenden Elements (5) 10 g/m<sup>2</sup>•24 Stunden oder weniger ist.

45

11. Schirm nach Anspruch 10, worin das Schutzschicht-stützende Element (5) mindestens eines ausgewählt aus Glas, Keramik, Metall oder Kunststoff umfaßt.

12. Schirm nach irgendeinem der Ansprüche 9 bis 11, worin das Schutzschicht-stützende Element (5) an dem Träger (4) und der Schutzschicht (1) mit einem Klebemittel angeklebt ist.

50

13. Schirm nach Anspruch 12, worin das Klebemittel mindestens eines ausgewählt aus einem Epoxyharz, einem Phenolharz, einem Cyanacrylatharz, einem Vinylacetatharz, einem Vinylchloridharz, einem Polyurethanharz, einem Acrylharz, einem Ethylen-Vinylacetatharz, einem Polyolefinharz, einem Chloroprenkautschuk, einem Nitrilkautschuk oder einem Siliconkautschuk ist.

55

14. Schirm nach irgendeinem der Ansprüche 9 bis 13, worin das Feuchtigkeitsabsorptionsvermögen des Schutzschichtstützenden Elements (5) höher ist als das der anregbaren Schicht (3).



15. Schirm nach Anspruch 14, worin das Schutzschicht-stützende Element (5) mindestens eines ausgewählt aus Polyvinylalkohol, Ethylen-Vinylalkohol-Copolymer, Polyacrylamid, Polyglycin, Polymethacrylsäure, Polyacrylsäure, Polyvinylpyrrolidon, Polyvinylamin, Cellulosediacetat, Cellulosetriacetat, Polyamid, Polyvinylacetat, Polymethylallylalkohol oder einem Feuchtigkeits-absorbierbaren Blatt, das Kieselgel oder Calciumcarbonat enthält, umfaßt.
16. Schirm nach Anspruch 14 oder 15, worin die äußere Seite des Schutzschicht-stützenden Elements (5) mit einem Versiegelungselement (82) aus einem Glas von niedrigem Schmelzpunkt abgedichtet ist.
17. Schirm nach Anspruch 9, worin das Schutzschicht-stützende Element (5) ein erstes feuchtigkeitsbeständiges Element (7a) und ein zweites feuchtigkeitsbeständiges Element (7b) umfaßt.
18. Schirm nach Anspruch 17, worin das erste feuchtigkeitsbeständige Element (7a) am Randteil der anregbaren Schicht (3) angeordnet ist und auf dem Träger (4) und der Schutzschicht (1) angeklebt ist.
19. Schirm nach Anspruch 17 oder 18, worin die Feuchtigkeitsdurchlässigkeit des ersten feuchtigkeitsbeständigen Elements (7a)  $10 \text{ g/m}^2 \cdot 24 \text{ Stunden}$  oder weniger ist.
20. Schirm nach Anspruch 19, worin das erste feuchtigkeitsbeständige Element (7a) mindestens eines ausgewählt aus chemisch verstärktem Glas; kristallisiertem Glas; Aluminiumoxid, Zirkoniumoxid, Aluminium, Eisen, Kupfer, Chrom; einem Metall, das mit einem Oxid von Aluminium, Eisen, Kupfer oder Chrom beschichtet ist; Celluloseacetat, Polyester, Polyethylenterephthalat, Polyamid, Polyimid, Triacetat oder Polycarbonat umfaßt.
21. Schirm nach irgendeinem der Ansprüche 17 bis 20, worin die Feuchtigkeitsdurchlässigkeit des zweiten feuchtigkeitsbeständigen Elements (7b)  $20 \text{ g/m}^2 \cdot 24 \text{ Stunden}$  oder weniger ist.
22. Schirm nach Anspruch 21, worin das zweite feuchtigkeitsbeständige Element (7b) mindestens eines ausgewählt aus einem Harz, welches durch Mischen von zwei Flüssigkeiten eines Urethanklebensmittels vom Zweipackungstyp, eines modifizierten Acrylatklebensmittels vom Zweipackungstyp, eines modifizierten Acrylklebensmittels vom Zweipackungstyp oder eines Epoxyklebensmittels vom Zweipackungstyp, um eine Polykondensationsreaktion oder eine Vernetzungsreaktion zu bewirken, aushärtet; oder einem Harz vom strahlungshärtenden Typ, das durch Bestrahlung mit einer elektromagnetischen Welle oder einem Teilchenstrahl, der ein Röntgenstrahl,  $\alpha$ -Strahl,  $\beta$ -Strahl,  $\gamma$ -Strahl, Hochenergieneutronenstrahl, Elektronenstrahl oder Ultraviolettstrahl ist, aushärtet, umfaßt.
23. Schirm nach irgendeinem der Ansprüche 17 bis 22, worin die Elastizität des ersten feuchtigkeitsbeständigen Elements (7a) niedriger ist als die des zweiten feuchtigkeitsbeständigen Elements (7b).
24. Schirm nach Anspruch 23, worin das erste feuchtigkeitsbeständige Element mindestens eines ausgewählt aus Celluloseacetat, Polyester, Polyethylenterephthalat, Polyamid, Polyimid, Triacetat, Polycarbonat, Polyethylen, Epoxyharz, Butadien-Styrol-Kautschuk, Butadien-Acrylnitril-Kautschuk, Isoprenkautschuk, chlorsulfoniertem Polyethylenkautschuk, Isobutylenkautschuk, Isobutylen-Isopren-Kautschuk, Acrylkautschuk, synthetischem Polysulfidkautschuk, Urethankautschuk, natürlichem Kautschuk, Propylenkautschuk, Styrolkautschuk, Butadienkautschuk, Siliconkautschuk oder Fluorkautschuk umfaßt.
25. Schirm nach Anspruch 17, worin die Kombination des ersten feuchtigkeitsbeständigen Elements (7a) und des zweiten feuchtigkeitsbeständigen Elements (7b) Urethankautschuk-Polyethylen, Polyethylen-Epoxyharz, Polyamidungesättigter Polyester oder Siliconkautschuk-Epoxyharz ist.
26. Schirm nach irgendeinem der Ansprüche 9 bis 25, worin die Randteile des Schutzschicht-stützenden Elements (5) mit einem Versiegelungsmittel (10), das ein Elastomer mit Feuchtigkeitsbeständigkeit und einer niedrigen Elastizität umfaßt, abgedichtet sind.
27. Schirm nach Anspruch 26, worin die Feuchtigkeitsdurchlässigkeit des Elastomers  $20 \text{ g/m}^2 \cdot 24 \text{ Stunden}$  unter den Bedingungen der Abdichtung des Speicherschirms ist.
28. Schirm nach Anspruch 26 oder 27, worin die Elastizität des Elastomers  $100 \text{ kg/mm}^2$  oder weniger ist.

29. Schirm nach irgendeinem der Ansprüche 26 bis 28, worin das Elastomer mindestens eines ausgewählt aus Polyethylen niedriger Dichte, weichem Epoxyharz, Naturkautschuk, Propylenkautschuk, Styrolkautschuk, Butadienkautschuk, Siliconkautschuk, Fluorkautschuk, Butadien-Styrol-Kautschuk, Butadien-Acrylnitril-Kautschuk, Isoprenkautschuk, chlorsulfoniertem Polyethylenkautschuk, Isobutylenkautschuk, Isobutylen-Isopren-Kautschuk, Acrylkautschuk, synthetischem Polysulfidkautschuk oder Urethankautschuk umfaßt.
30. Schirm nach irgendeinem der Ansprüche 9 bis 29, worin das Gas, das in der Zwischenschicht (2) enthalten ist, ein getrocknetes Gas, ausgewählt aus He, Ne, Ar, O<sub>2</sub>, H<sub>2</sub> und CO<sub>2</sub>, ist.
31. Schirm nach Anspruch 30, worin der Wassergehalt des getrockneten Gases 5,0 mg/l oder weniger ist.
32. Schirm nach irgendeinem der Ansprüche 9 bis 31, worin ein hygroskopisches Mittel (9) zwischen dem Träger (4) und der Schutzschicht (1) angeordnet ist.
33. Schirm nach Anspruch 32, worin die Wasserabsorptionsmenge des hygroskopischen Mittels (9) 0,1 bis 50 mg pro 1 g des anregbaren Phosphors ist.
34. Schirm nach Anspruch 32 oder 33, worin das hygroskopische Mittel (9) mindestens eines ausgewählt aus Kieselgel, CaCl<sub>2</sub>, LiCl, Polyvinylalkohol oder Ethylen-Vinylalkohol-Copolymer ist.
35. Schirm nach Anspruch 1, worin die Zwischenschicht (2) von CaF<sub>2</sub>, Na<sub>3</sub>AlF<sub>6</sub>, MgF<sub>2</sub> oder SiO<sub>2</sub> mindestens eines ist.
36. Schirm nach irgendeinem der vorangehenden Ansprüche, worin der Brechungsindex der Schutzschicht (1) 1,4 bis 2,0 ist.
37. Schirm nach irgendeinem der vorangehenden Ansprüche, worin die Feuchtigkeitsdurchlässigkeit der Schutzschicht (1) 10 g/m<sup>2</sup>•24 Stunden oder weniger ist.
38. Schirm nach Anspruch 37, worin die Schutzschicht (1) von Quarz, Borsilicatglas, chemisch verstärktem Glas, Polyethylenterephthalat, orientierten Polypropylen oder Polyvinylchlorid mindestens eines ist.
39. Schirm nach Anspruch 38, worin die Schutzschicht von Quarz, Borsilicatglas oder chemisch verstärktem Glas mindestens eines ist.
40. Schirm nach irgendeinem der Ansprüche 37 bis 39, worin die Lichtdurchlässigkeit der Schutzschicht (1) 80% oder mehr ist.
41. Schirm nach irgendeinem der Ansprüche 1 bis 35, worin die Schutzschicht (1) zwei oder mehr Schichten (1a und 1b) mit verschiedenen Feuchtigkeitsabsorptionsvermögen umfaßt.
42. Schirm nach Anspruch 41, worin die Schutzschicht (1) eine Schutzschicht mit einem kleineren Feuchtigkeitsabsorptionsvermögen (1b) auf der Außenseite und eine Schutzschicht mit einem größeren Feuchtigkeitsabsorptionsvermögen (1a) auf der Seite der anregbaren Schicht (3) umfaßt.
43. Schirm nach Anspruch 42, worin die Schutzschicht mit einem kleineren Feuchtigkeitsabsorptionsvermögen (1b) von einem Spiegelglas, Polyethylen oder Polytetrafluorethylen mindestens eines umfaßt.
44. Schirm nach Anspruch 42 oder 43, worin die Schutzschicht mit einem größeren Feuchtigkeitsabsorptionsvermögen (1a) Polyvinylalkohol oder Ethylen-Vinylalkohol-Copolymer umfaßt.
45. Schirm nach irgendeinem der vorangehenden Ansprüche, worin eine Schicht mit einem höheren Brechungsindex (2b), die einen höheren Brechungsindex als die Zwischenschicht (2a) aufweist, zwischen der Zwischenschicht (2a) und der anregbaren Schicht (3) angeordnet ist.
46. Schirm nach Anspruch 45, worin die Schicht mit höherem Brechungsindex (2b) von Al<sub>2</sub>O<sub>3</sub>, Sb<sub>2</sub>O<sub>3</sub>, CeO<sub>2</sub>, CeF<sub>3</sub>, La<sub>2</sub>O<sub>3</sub>, LaF<sub>3</sub>, PbF<sub>3</sub>, NdF<sub>3</sub>, Pr<sub>6</sub>O<sub>11</sub>, SiO, SiO<sub>2</sub>, TiO<sub>2</sub>, ThO<sub>2</sub>, ThF<sub>4</sub>, ZnS oder ZrO<sub>2</sub>

mindestens eines umfaßt.

47. Schirm nach Anspruch 45, worin die Schicht mit höherem Brechungsindex (2b) ein Material mit einem hohen Feuchtigkeitsabsorptionsvermögen umfaßt.
- 5 48. Schirm nach Anspruch 47, worin die Gleichgewichts-Feuchtigkeitsabsorptionsrate der Schicht mit höherem Brechungsindex (2b) bei einer Temperatur von 25 °C und einer relativen Feuchtigkeit von 65% 1% oder mehr ist.
- 10 49. Schirm nach irgendeinem der vorangehenden Ansprüche, worin die Feuchtigkeitsdurchlässigkeit des Trägers (4) 10 g/m<sup>2</sup>·24 Stunden oder weniger ist.
- 15 50. Schirm nach Anspruch 49, worin der Träger (4) von chemisch verstärktem Glas, kristallisiertem Glas; Aluminiumoxid, Zirkoniumoxid, Aluminium, Eisen, Kupfer, Chrom; einem Metall, das mit einem Oxid von Aluminium, Eisen, Kupfer oder Chrom beschichtet ist; Celluloseacetat, Polyester, Polyethylenterephthalat, Polyamid, Polyimid, Triacetat oder Polycarbonat mindestens eines umfaßt.
- 20 51. Verfahren zur Herstellung eines Schirms, wie in irgendeinem der Ansprüche 9 bis 34 oder der Ansprüche 36 bis 50, wenn diese von irgendeinem der Ansprüche 9 bis 34 abhängen, definiert, umfassend das Anordnen des Schutzschicht-stützenden Elements (5) zwischen dem Träger (4) und der Schutzschicht (1), derart, daß die Ränder der anregbaren Schicht (3) umgeben und abgedichtet werden, das Versehen des Schutzschicht-stützenden Elements (5) mit mindestens einem Schlitz, der als Belüftungsloch wirkt, das Erhitzen und Trocknen des Schirms und das anschließende Abdichten des Schlitzes oder der Schlitzes.
- 25 52. Verfahren nach Anspruch 51, worin das Erhitzen und Trocknen bei 40 bis 100 °C über 0,1 bis 3 Stunden durchgeführt werden.
- 30 53. Verfahren nach Anspruch 51 oder 52, worin das Erhitzen und Trocknen unter reduzierten Druck durchgeführt werden.
54. Verfahren nach irgendeinem der Ansprüche 51 bis 53, worin die Anzahl der Schlitzes 1 oder 2 ist.
55. Verfahren nach irgendeinem der Ansprüche 51 bis 54, worin die Breite des Schlitzes 2 bis 40 mm ist.
- 35 56. Verfahren nach irgendeinem der Ansprüche 51 bis 55, worin Luft innerhalb des Speicherschirms nach dem Erhitzen und Trocknen durch ein getrocknetes Gas ersetzt wird.
- 40 57. Verfahren nach Anspruch 56, worin der Wassergehalt des getrockneten Gases 5,0 mg/l oder weniger ist.
58. Verfahren nach Anspruch 56 oder 57, worin das Gas mindestens eines ausgewählt aus He, Ne, Ar, O<sub>2</sub>, H<sub>2</sub> oder CO<sub>2</sub> ist.

#### 45 Revendications

- 50 1. Ecran pour l'enregistrement d'une image obtenue par rayonnement, comprenant une couche de phosphore stimuable (3), une couche protectrice (1) et une couche intermédiaire (2), placée entre la couche stimuable (3) et la couche protectrice (1), sur un support (4), caractérisé en ce que la couche intermédiaire (2) présente un indice de réfraction inférieur à celui de la couche protectrice (1).
2. Ecran selon la revendication 1, dans lequel l'indice de réfraction de la couche intermédiaire (2) est pratiquement égal à 1.
- 55 3. Ecran selon la revendication 1, dans lequel la couche intermédiaire (2) est une couche gazeuse.
4. Ecran selon la revendication 3, dans lequel le gaz contenu dans la couche intermédiaire (2) est au moins de l'air, de l'azote ou de l'argon.

5. Ecran selon la revendication 2, dans lequel la couche intermédiaire (2) est une couche de vide.
6. Ecran selon la revendication 1, dans lequel la couche intermédiaire (2) est une couche liquide.
7. Ecran selon la revendication 6, dans lequel le liquide contenu dans la couche intermédiaire (2) est au moins de l'alcool éthylique, de l'alcool méthylique ou du diéthyléther.
8. Ecran selon l'une quelconque des revendications 3 à 7, dans lequel la couche intermédiaire (2) contient un matériau écarteur (6).
9. Ecran selon l'une quelconque des revendications 3 à 7, dans lequel la couche intermédiaire (2) est formée par disposition d'un élément de support (5) de la couche protectrice, ayant une épaisseur supérieure à celle de la couche stimulable (3), de façon à ce que la couche stimulable (3) soit entourée par l'élément de support (5) de la couche protectrice.
10. Ecran selon la revendication 9, dans lequel la perméabilité à l'humidité de l'élément de support (5) de la couche protectrice est d'au plus  $10 \text{ g/m}^2 \cdot 24 \text{ heures}$ .
11. Ecran selon la revendication 10, dans lequel l'élément de support (5) de la couche protectrice comprend au moins du verre, un matériau céramique, un métal ou une matière plastique.
12. Ecran selon l'une quelconque des revendications 9 à 11, dans lequel l'élément de support (5) de la couche protectrice est fixé par adhérence au support (4) et à la couche protectrice (1) par l'intermédiaire d'un adhésif.
13. Ecran selon la revendication 12, dans lequel l'adhésif est au moins une résine choisie parmi une résine époxy, une résine phénolique, une résine cyanoacrylate, une résine acétate de vinyle, une résine chlorure de vinyle, une résine polyuréthane, une résine acrylique, une résine éthylène-acétate de vinyle, une résine polyoléfine, un caoutchouc chloroprène, un caoutchouc nitrile ou une résine silicone.
14. Ecran selon l'une quelconque des revendications 9 à 13, dans lequel la capacité d'absorption de l'humidité de l'élément de support (5) de la couche protectrice est supérieure à celle de la couche stimulable (3).
15. Ecran selon la revendication 14, dans lequel ledit élément de support (5) de la couche protectrice comprend au moins un poly(alcool vinylique), un copolymère éthylène-alcool vinylique, un polyacrylamide, de la polyglycine, un poly(acide méthacrylique), un poly(acide acrylique), de la poly(vinylpyrrolidone), de la poly(vinylamine), du diacétate de cellulose, du triacétate de cellulose, un polyamide, du poly(acétate de vinyle), un poly(alcool méthylallylique) ou une feuille absorbant l'humidité contenant un gel de silice ou du carbonate de calcium.
16. Ecran selon la revendication 14 ou 15, dans lequel l'extérieur de l'élément de support (5) de la couche protectrice est rendu étanche à l'aide d'un élément d'étanchéité (82) constitué d'un verre à bas point de fusion.
17. Ecran selon la revendication 9, dans lequel l'élément de support (5) de la couche protectrice comprend un premier élément (7a) résistant à l'humidité et un second élément (7b) résistant à l'humidité.
18. Ecran selon la revendication 17, dans lequel le premier élément (7a) résistant à l'humidité est disposé sur la partie de bord de la couche stimulable (3) et est fixé par adhérence au support (4) et à la couche protectrice (1).
19. Ecran selon la revendication 17 ou 18, dans lequel la perméabilité à l'humidité du premier élément (7a) résistant à l'humidité est d'au plus  $10 \text{ g/m}^2 \cdot 24 \text{ heures}$ .
20. Ecran selon la revendication 19, dans lequel le premier élément (7a) résistant à l'humidité comprend au moins du verre renforcé chimiquement ; du verre cristallisé ; de l'alumine, de la zircone, de l'aluminium, du fer, du cuivre ou du chrome ; un métal revêtu avec un oxyde d'aluminium, de fer, de

cuivre ou de chrome; de l'acétate de cellulose, du polyester, du téréphtalate de polyéthylène, du polyamide, du polyimide, du triacétate ou du polycarbonate.

21. Ecran selon l'une quelconque des revendications 17 à 20, dans lequel la perméabilité à l'humidité du second élément (7b) résistant à l'humidité est d'au plus  $10 \text{ g/m}^2 \cdot 24 \text{ heures}$ .
22. Ecran selon la revendication 21, dans lequel le second élément (7b) résistant à l'humidité comprend au moins une résine qui durcit par mélange de deux liquides d'un agent adhésif à deux composants à base d'uréthane, d'un agent adhésif à deux composants à base d'acrylate modifié, d'un agent adhésif à deux composants à base de résine acrylique modifiée ou d'un agent adhésif à deux composants à base de résine époxy, pour effectuer une réaction de polycondensation ou une réaction de réticulation : ou une résine du type durcissant par irradiation, qui durcit par irradiation à l'aide d'ondes électromagnétiques ou d'un faisceau corpusculaire qui est un rayon X, un rayon  $\alpha$ , un rayon  $\beta$ , un rayon  $\gamma$ , un faisceau de neutrons à énergie élevée, un faisceau d'électrons ou un rayon ultraviolet.
23. Ecran selon l'une quelconque des revendications 17 à 22, dans lequel l'élasticité du premier élément résistant à l'humidité (7a) est inférieure à celle du second élément résistant à l'humidité (7b).
24. Ecran selon la revendication 23, dans lequel le premier élément résistant à l'humidité comprend au moins de l'acétate de cellulose, du polyester, du téréphtalate de polyéthylène, du polyamide, du polyimide, du triacétate, du polycarbonate, du polyéthylène, une résine époxy, du caoutchouc butadiène-styrène, du caoutchouc butadiène-acrylonitrile, du caoutchouc isoprène, du caoutchouc polyéthylène chlorosulfoné, du caoutchouc isobutylène, du caoutchouc isobutylène-isoprène, du caoutchouc acrylique, du caoutchouc de polysulfure synthétique, du caoutchouc uréthane, du caoutchouc naturel, du caoutchouc propylène, du caoutchouc styrène, du caoutchouc butadiène, du caoutchouc silicone ou du caoutchouc fluoré.
25. Ecran selon la revendication 17, dans lequel la combinaison du premier élément résistant à l'humidité (7a) et du second élément résistant à l'humidité (7b) est une combinaison caoutchouc uréthane-polyéthylène, polyéthylène-résine époxy, polyamide-polyester insaturé ou caoutchouc silicone-résine époxy.
26. Ecran selon l'une quelconque des revendications 9 à 25, dans lequel les parties de bord de l'élément de support (5) de la couche protectrice sont rendues étanches à l'aide d'un agent d'étanchéité (10) comprenant un élastomère ayant une résistance à l'humidité et une faible élasticité.
27. Ecran selon la revendication 26, dans lequel la perméabilité à l'humidité de l'élastomère est de  $20 \text{ g/m}^2 \cdot 24 \text{ heures}$  dans les conditions où l'écran d'enregistrement est rendu étanche.
28. Ecran selon la revendication 26 ou 27, dans lequel l'élasticité de l'élastomère d'au plus  $100 \text{ kg/mm}^2$ .
29. Ecran selon l'une quelconque des revendications 26 à 28, dans lequel l'élastomère comprend au moins un polyéthylène basse densité, une résine époxy molle, du caoutchouc naturel, du caoutchouc propylène, du caoutchouc styrène, du caoutchouc butadiène, du caoutchouc silicone, du caoutchouc fluoré, du caoutchouc butadiène-styrène, du caoutchouc butadiène-acrylonitrile, du caoutchouc isoprène, du caoutchouc polyéthylène chlorosulfoné, du caoutchouc isobutylène, du caoutchouc isobutylène-isoprène, du caoutchouc acrylique, du caoutchouc polysulfure synthétique ou du caoutchouc uréthane.
30. Ecran selon l'une quelconque des revendications 9 à 29, dans lequel le gaz contenu dans la couche intermédiaire (2) est un gaz séché choisi parmi He, Ne, Ar,  $\text{O}_2$ ,  $\text{H}_2$  et  $\text{CO}_2$ .
31. Ecran selon la revendication 30, dans lequel la teneur en eau du gaz séché est d'au plus  $5,0 \text{ mg/litre}$ .
32. Ecran selon l'une quelconque des revendications 9 à 31, dans lequel un agent hygroscopique (9) est prévu entre le support (4) et la couche protectrice (1).
33. Ecran selon la revendication 32, dans lequel la quantité d'eau par absorption de l'agent hygroscopique (9) est de  $0,1$  à  $50 \text{ mg}$  pour  $1 \text{ g}$  du phosphore stimuable.

34. Ecran selon la revendication 32 ou 33, dans lequel l'agent hygroscopique (9) est au moins un gel de silice,  $\text{CaCl}_2$ ,  $\text{LiCl}$ , le poly(alcool vinylique) ou un copolymère éthylène-alcool vinylique.
- 5 35. Ecran selon la revendication 1, dans lequel la couche intermédiaire (2) est en au moins des composés  $\text{CaF}_2$ ,  $\text{Na}_3\text{AlF}_6$ ,  $\text{MgF}_2$  ou  $\text{SiO}_2$ .
36. Ecran selon l'une quelconque des revendications précédentes, dans lequel l'indice de réfraction de la couche protectrice (1) est de 1,4 à 2,0.
- 10 37. Ecran selon l'une quelconque des revendications précédentes, dans lequel la perméabilité à l'humidité de la couche protectrice (1) est ou plus de  $10 \text{ g/m}^2 \cdot 24 \text{ heures}$ .
38. Ecran selon la revendication 37, dans lequel la couche protectrice (1) est en au moins du quartz, du verre de borosilicate, du verre renforcé chimiquement, du téréphtalate de polyéthylène, du polypropylène orienté ou du poly(chlorure de vinyle).
- 15 39. Ecran selon la revendication 38, dans lequel la couche protectrice (1) est en au moins du quartz, du verre de borosilicate ou du verre renforcé chimiquement.
- 20 40. Ecran selon l'une quelconque des revendications 37 à 39, dans lequel la transmission de la lumière par la couche protectrice (1) est au moins de 80%.
41. Ecran selon l'une quelconque des revendications 1 à 35, dans lequel la couche protectrice (1) comprend deux ou plus de deux couches (1a et 1b) ayant des capacités d'absorption de l'humidité différentes.
- 25 42. Ecran selon l'une quelconque des revendications 1 à 35, dans lequel la couche protectrice (1) comprend une couche protectrice ayant une plus faible capacité d'absorption de l'humidité (1b) à l'extérieur et une couche protectrice ayant une capacité d'absorption de l'humidité (1a) supérieure du côté de la couche stimulable (3).
- 30 43. Ecran selon la revendication 42, dans lequel la couche protectrice ayant une plus faible capacité d'absorption (1b) comprend au moins une plaque de verre, du polyéthylène ou du polytétrafluoroéthylène.
- 35 44. Ecran selon la revendication 42 ou 43, dans lequel la couche protectrice ayant une plus grande capacité d'absorption de l'humidité (1a) comprend du poly(alcool vinylique) ou un copolymère éthylène-alcool vinylique.
- 40 45. Ecran selon l'une quelconque des revendications précédentes, dans lequel une couche (2b) d'indice de réfraction élevé, supérieur à l'indice de réfraction de la couche intermédiaire (2a), est prévue entre la couche intermédiaire (2a) et la couche stimulable (3).
- 45 46. Ecran selon la revendication 45, dans lequel la couche (2b) ayant un indice de réfraction élevé contient au moins  $\text{Al}_2\text{O}_3$ ,  $\text{Sb}_2\text{O}_3$ ,  $\text{CeO}_2$ ,  $\text{CeF}_3$ ,  $\text{La}_2\text{O}_3$ ,  $\text{LaF}_3$ ,  $\text{PbF}_3$ ,  $\text{NdF}_3$ ,  $\text{Pr}_6\text{O}_{11}$ ,  $\text{SiO}_2$ ,  $\text{TiO}_2$ ,  $\text{ThO}_2$ ,  $\text{ThF}_4$ ,  $\text{ZnS}$  ou  $\text{ZnO}_2$ .
47. Ecran selon la revendication 45, dans lequel la couche (2b) ayant un indice de réfraction élevé contient une substance ayant une capacité d'absorption élevée de l'humidité.
- 50 48. Ecran selon la revendication 47, dans lequel le taux d'absorption de l'humidité à l'équilibre de la couche (2b) ayant l'indice de réfraction élevé à une température de  $25^\circ\text{C}$  et une humidité relative de 65%, est d'au moins 1%.
- 55 49. Ecran selon l'une quelconque des revendications précédentes, dans lequel la perméabilité à l'humidité du support (4) est d'au plus  $10 \text{ g/m}^2 \cdot 24 \text{ heures}$ .
50. Ecran selon la revendication 49, dans lequel le support (4) comprend au moins du verre renforcé

chimiquement, du verre cristallisé ; de l'alumine, de la zircone, de l'aluminium, du fer, du cuivre, du chrome ; un métal revêtu avec un oxyde d'aluminium, de fer, de cuivre ou de chrome ; de l'acétate de cellulose, du polyester, du téréphtalate de polyéthylène, du polyamide, du polyimide, du triacétate ou du polycarbonate.

5

10

15

20

25

30

35

40

45

50

55

51. Procédé pour la préparation d'un écran tel que défini dans l'une quelconque des revendications 9 à 34 ou dans les revendications 36 à 50, lorsqu'elles sont dépendantes de l'une quelconque des revendications 9 à 34, qui consiste à disposer l'élément de support (5) de la couche protectrice entre le support (4) et la couche protectrice (1) de façon à entourer et sceller les bords de la couche stimulable (3), à disposer dans l'élément de support (5) de la couche protectrice au moins une encoche qui fonctionne comme un orifice de ventilation, à chauffer et à sécher l'écran, et à sceller le ou les encoches.

52. Procédé selon la revendication 51, dans lequel le chauffage et le séchage sont réalisés à une température de 40 à 100 ° C pendant 0,1 à 3 heures.

53. Procédé selon la revendication 51 ou 52, dans lequel le chauffage et le séchage sont réalisés sous pression réduite.

54. Procédé selon l'une quelconque des revendications 51 à 53, dans lequel le nombre desdites encoches est de un ou deux.

55. Procédé selon l'une quelconque des revendications 51 à 54, dans lequel la largeur de l'encoche est de 2 à 40 mm.

56. Procédé selon l'une quelconque des revendications 51 à 55, dans lequel l'air à l'intérieur de l'écran d'enregistrement est remplacé par un gaz séché après le chauffage et le séchage.

57. Procédé selon la revendication 56, dans lequel la teneur en eau du gaz séché est d'au plus 5,0 mg/litre.

58. Procédé selon la revendication 56 ou 57, dans lequel le gaz est choisi parmi He, Ne, Ar, O<sub>2</sub>, H<sub>2</sub> et CO<sub>2</sub>.

FIG. 1

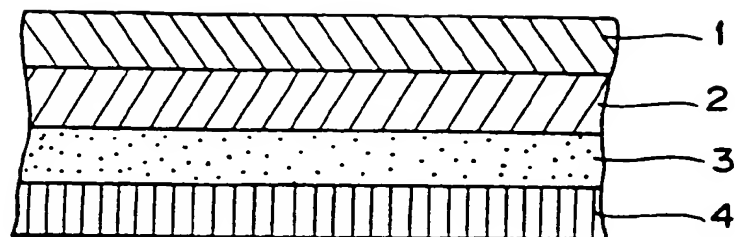


FIG. 2A

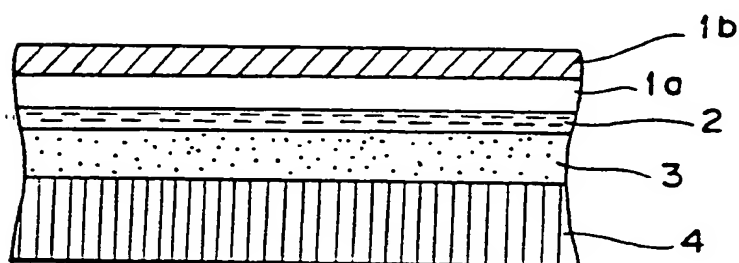


FIG. 2B

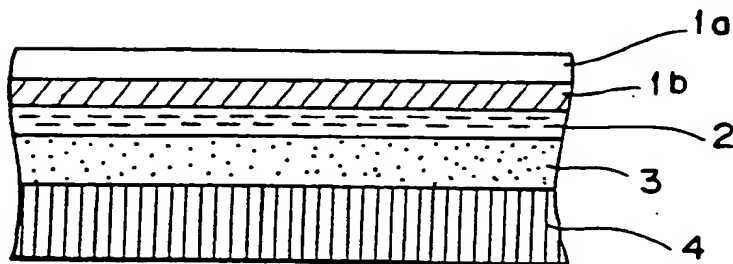




FIG. 3

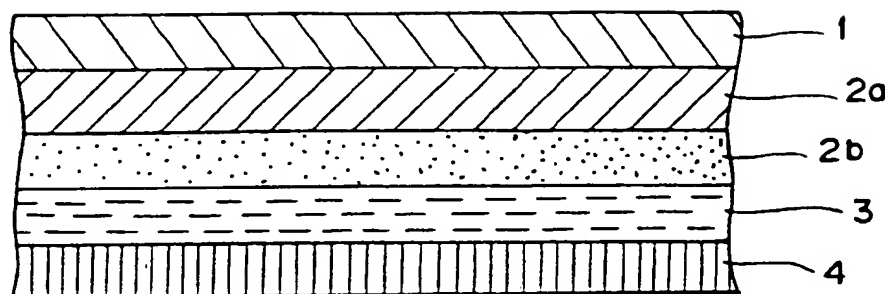


FIG. 4

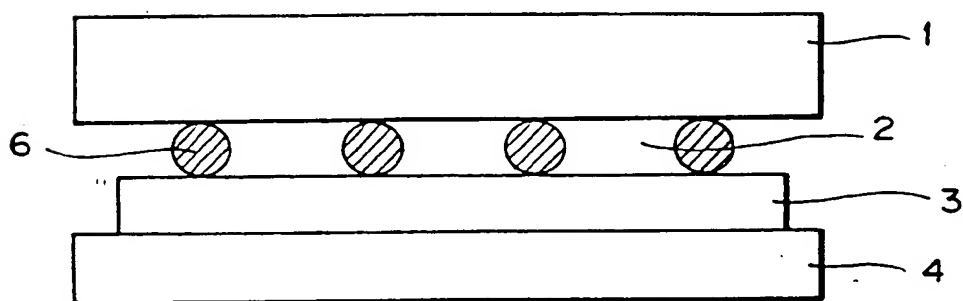


FIG. 5

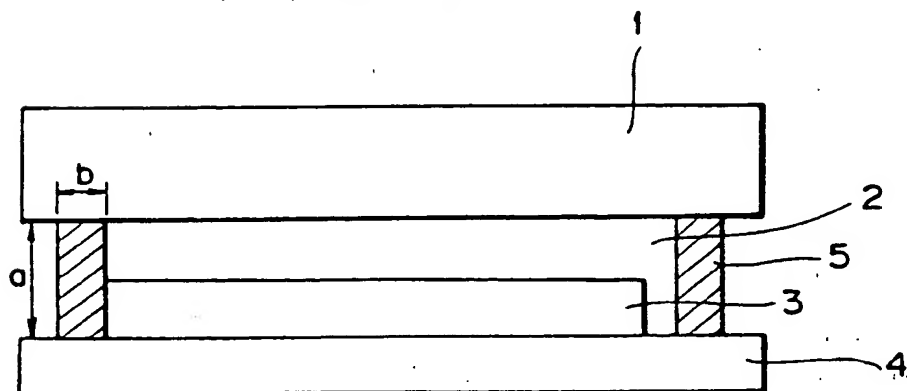


FIG. 6

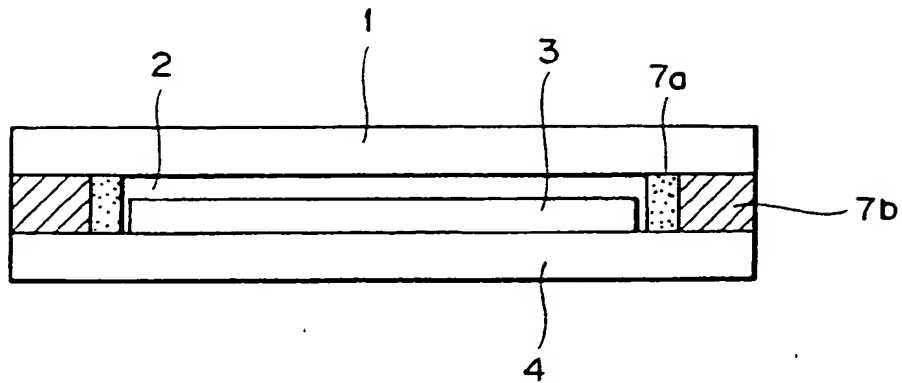


FIG. 7A

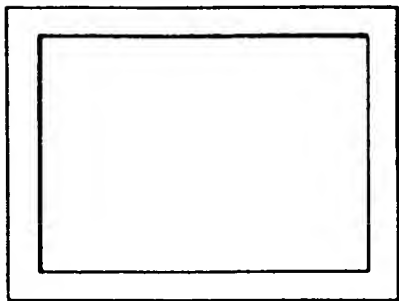


FIG. 7B

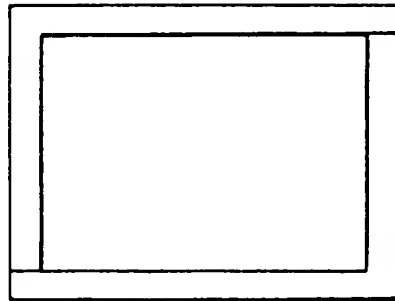


FIG. 7C

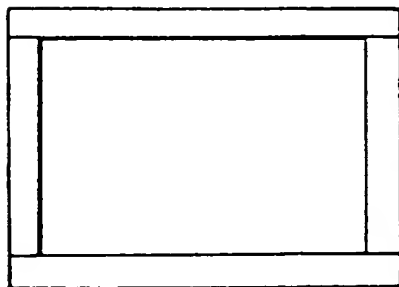


FIG. 8

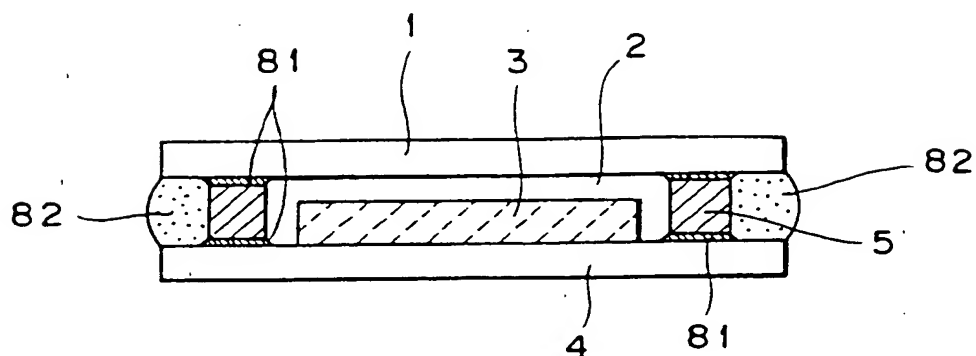


FIG. 9

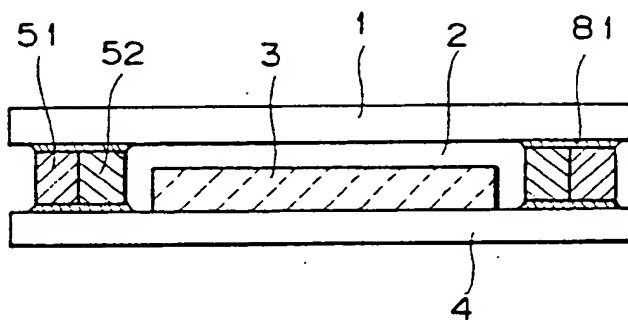


FIG. 10

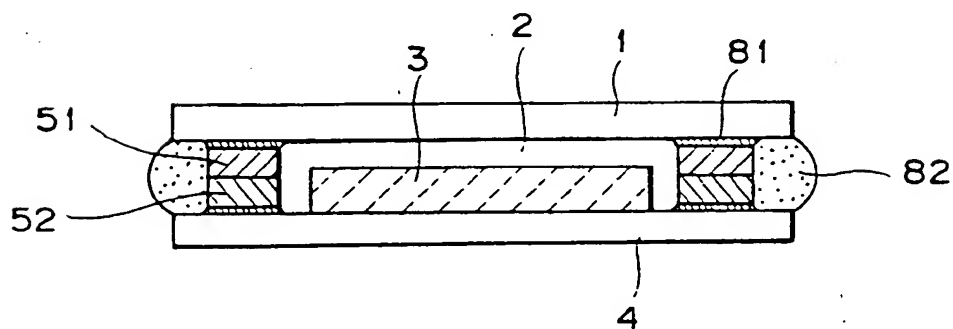


FIG. 11

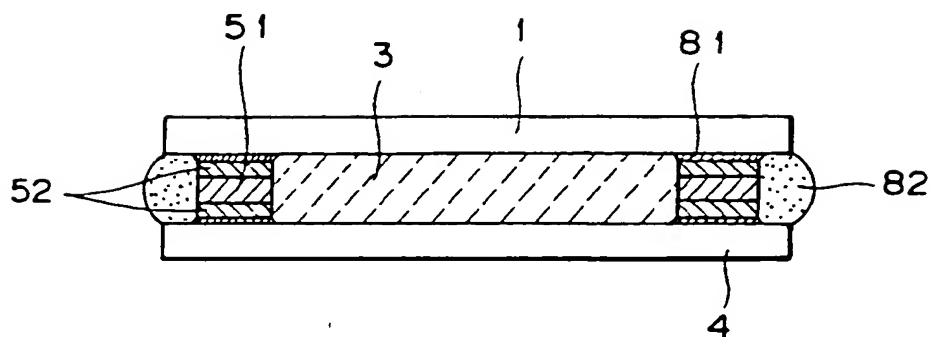


FIG. 12

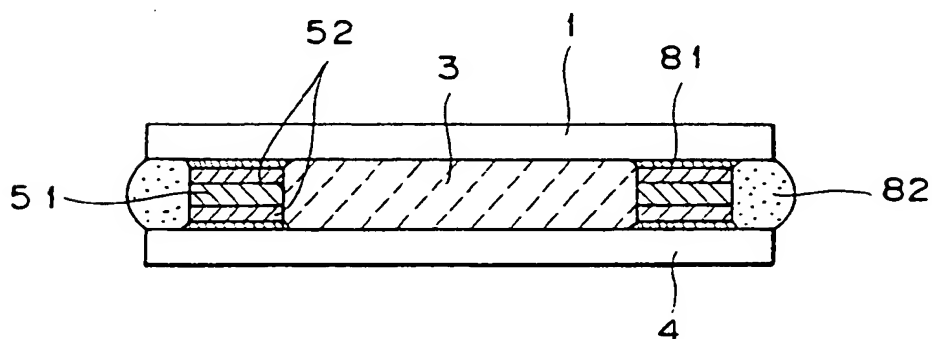


FIG. 13

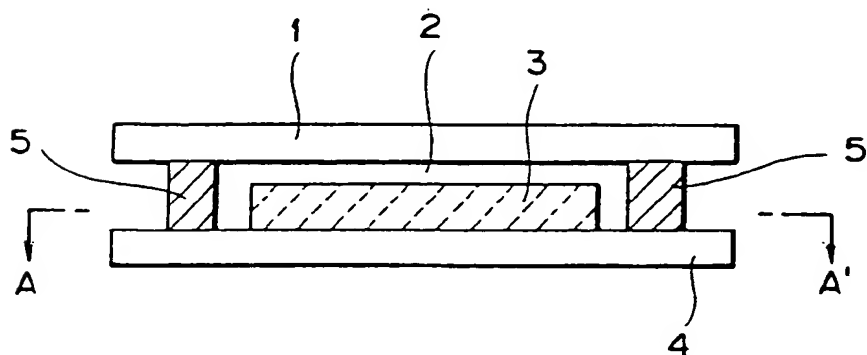


FIG. 14

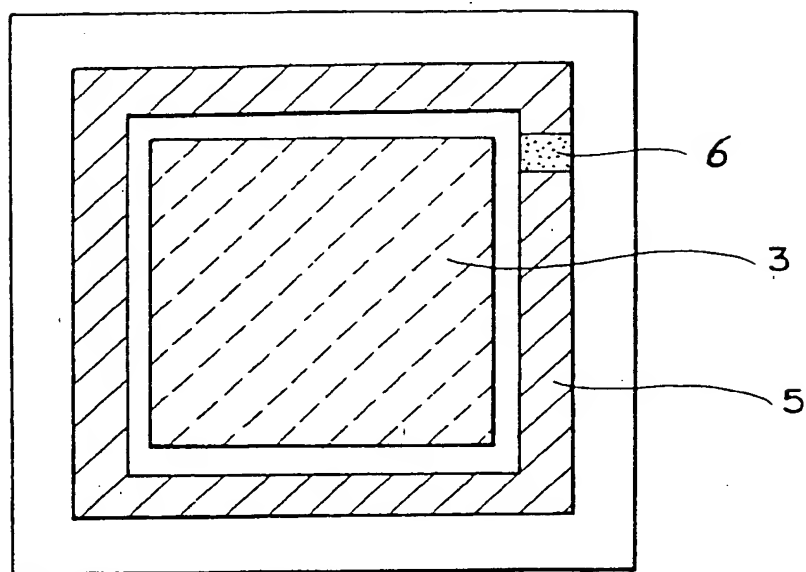


FIG. 15

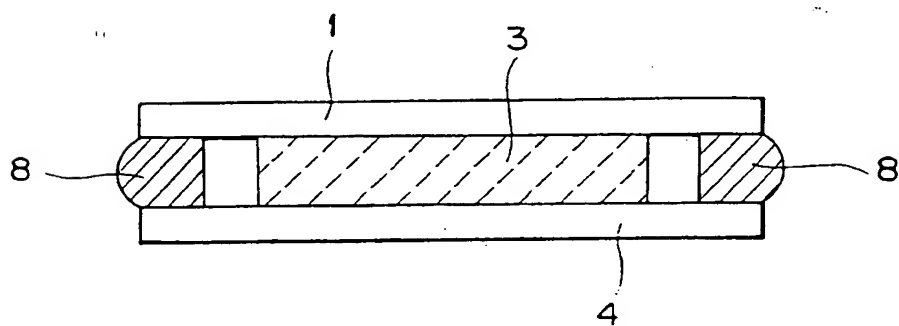


FIG. 16

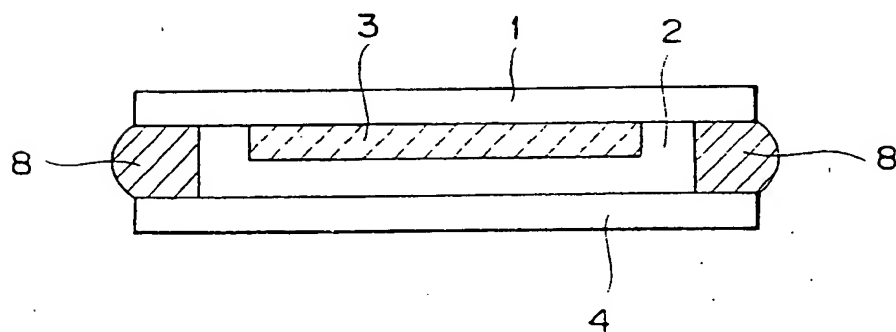


FIG. 17

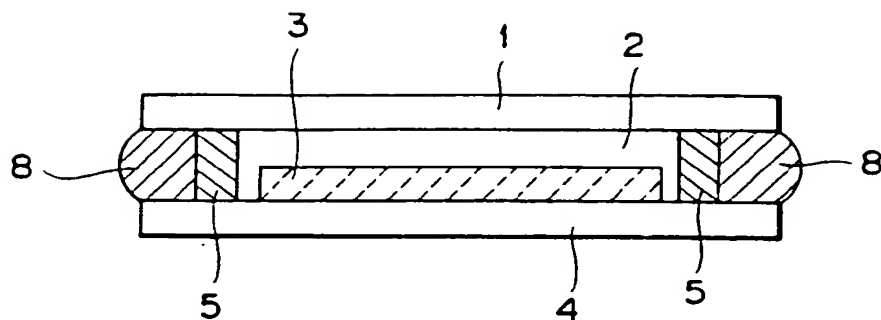


FIG. 18

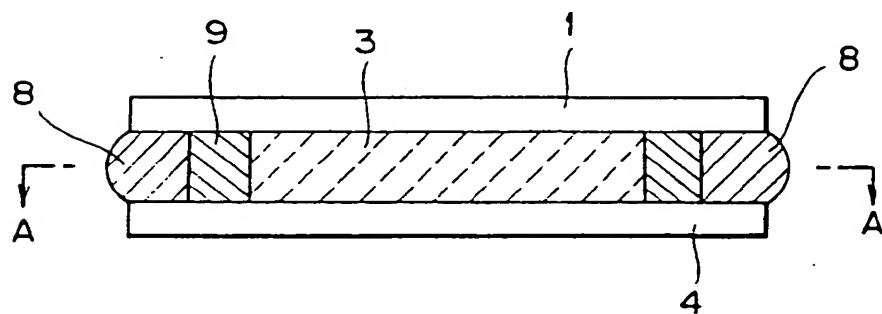


FIG. 19

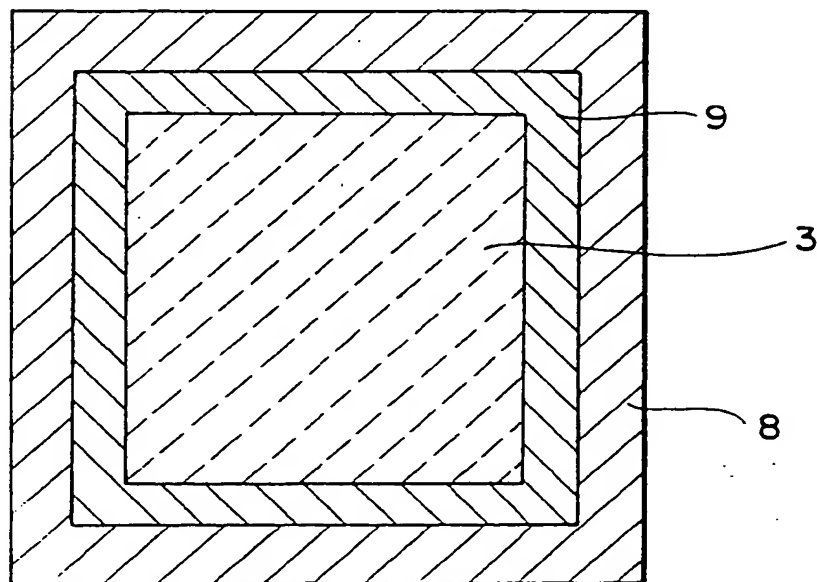


FIG. 20

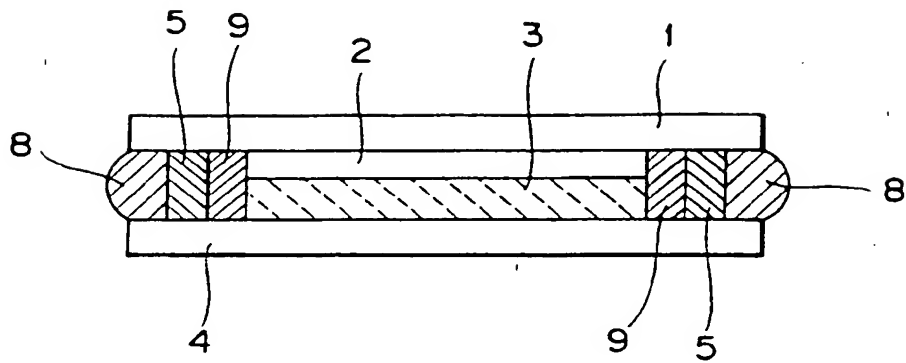


FIG. 21

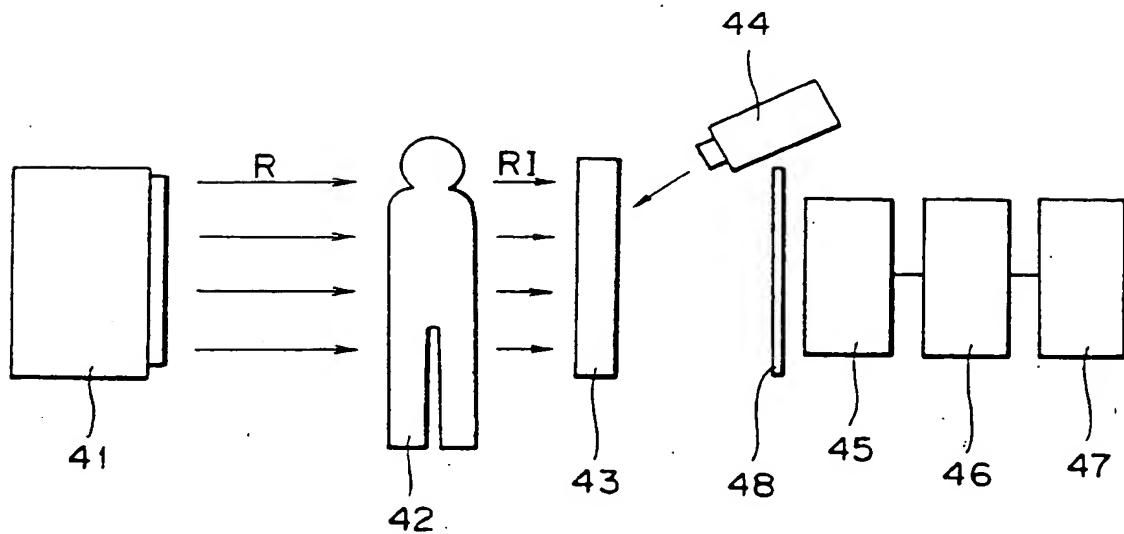


FIG. 22A

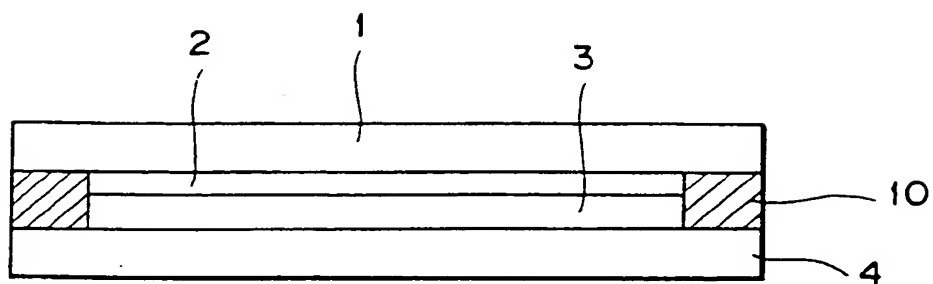


FIG. 22B

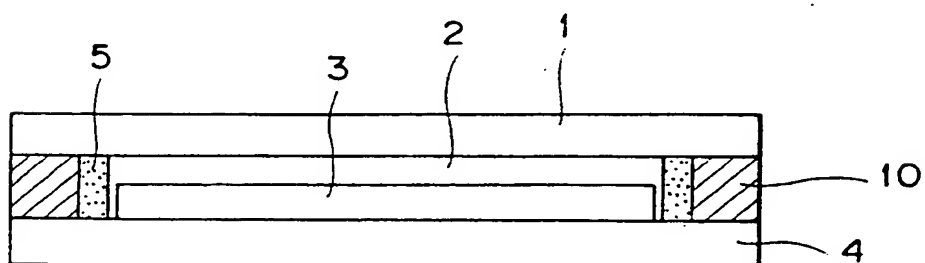


FIG. 23

